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THE
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THE HOUSES OF RURAL BRAZIL

By ROY NASH

"However rudimentary," says Brunhes, "the sleep shelter is still a definite point at which man installs himself for some hours and to which he is naturally inclined to return. Such is the origin of that very important fact of human geography, the habitation."

We shall use the term "house" as he does, to include all human structures; but, inasmuch as it is especially the rural house and the isolated dwelling that necessarily is built of local materials and most clearly exhibits dependence upon the geographical environment, we shall here shun the cities of Brazil. Every one who travels in South America knows Rio de Janeiro and Bahia, Santos and São Paulo; far fewer know well the interior.

PALM-LEAF HUTS

For the first type of Brazilian house let us observe this palm-leaf hut on the Banks of Breves, at the mouth of the Amazon (Fig. 1). Just some piles to raise the floor above the mud, three walls of woven matting, and some thatch; but a sleep shelter, a protection against the storm, and a place where the owner may accumulate nets and spears and all his beloved possessions. Such is the type that has risen in the plains of the Lower Amazon subject to annual floods—mere frameworks raised high on wooden piles and thatched with the leaves of the ubussú palm or the assai. The outer part of the stem of the latter species is hard and tough as horn. Split into narrow planks, it is used along the Tocantins for a large portion of the walls and flooring.

Up toward the headwaters of the Amazon the forest Indians build communal dwellings large enough to house the whole village.[1] The walls as well as the roof are covered with thatch of palm leaves. On festive occasions a *maloca* may shelter as many as two hundred naked dancers, and we know not how many chiefs sitting with their knees doubled in the burial urns beneath the trampled earth on which their descendants are dancing. With

[1] Pictures and plans of *maloca* of the upper Amazon are given, for instance, in Thomas Whiffen's "The North-west Amazons."

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only two apertures in the whole great edifice to admit light and air and permit the smoke from the many fires to escape, it is fortunate indeed that palm thatch is porous! These communal dwellings were originally found from Colombia to Paraguay and eastward to Rio de Janeiro.

The *malocas* of the Upper Amazon are the limit of the palm-leaf house in the direction of magnitude. At the other end of the scale are such temporary shelters as the one shown from Matto Grosso (Fig. 2). Wherever men camp in the jungle for a brief sojourn, as do the *seringueiros* who gather rubber during part of each year, similar frail structures, which can be thrown together in an hour's time, are made to suffice for several months.

The palm-leaf hut in its various forms was one of the houses which existed in Brazil before the invasion of the Portuguese.

The Mud House

The vast majority of houses of rural Brazil are of mud. The *gaucho* who herds cattle on the pampas of Rio Grande do Sul, the *matuto* who plants his crops throughout the forest regions of the central plateau and along the littoral, the *sertanejo* who wrests a precarious livelihood from that dry region which extends from northern Minas to the coast of Maranhão and Ceará, and even those who live in the villages along the navigable rivers of the Amazon Basin, all build the same type of house. "Huts of refuge of the same dreary material as the hills" are as typical of Brazil as of Lower Egypt.

Possibly the mud house in some form or other was in use among the aborigines before the arrival of the Portuguese. It was known in parts of South America; wattle and daub, for instance, were characteristic of the Chibcha culture area. However this may be, the present prevalence of the mud house type appears to be a result of Portuguese culture. The mud house has always been common on the Iberian Peninsula and about the Mediterranean.

It may seem strange that a thing as ephemeral as the mud house should persist and keep the same general characteristics through the centuries in a country which has more standing timber than any other like area of the earth's surface. The fellah in the delta of the Nile lacks everything that is necessary to construct a solid dwelling, but the Brazilian has stone and wood and lime and fuel to burn bricks in abundance. What is the reason for this, beyond the tremendous force of tradition?

One reason is clear. There are, even today, only two establishments in all Brazil which would be classed by North American lumbermen as thoroughly modern sawmills. The boards used by the hinterland for the most part are whipsawed by hand, as for centuries past. While Brazilian forests are rich in an enormous variety of timbers, many are very hard and saw with difficulty. Whipsawed lumber is vastly expensive in labor.

On the contrary, nothing could be easier to build than the mud house of Brazil. Four corner posts and two to support the ridgepole are set into the

FIG. 1

FIG. 2

FIG. 1—The palm-leaf hut of the flood plain of the Lower Amazon. It is raised on piles just high enough to keep the floor above high-water level. In the Breves channel, west of the Island of Marajó.

FIG. 2—The simplest form of palm-leaf hut. A temporary shelter in Matto Grosso.

ground, and rafters are fastened to their tops. If nails are expensive, the forest is full of flexible bark and *sipós* which make strong ties. The forest furnishes the builder with the saplings which are fixed vertically between the ground and the rafters a palm's width apart, and with the withes which are woven in horizontally until the walls are outlined as a wattlework of five or six-inch squares. Plaster into this wattle any good heavy clay, and you have a wall which will soon dry to considerable hardness.

FIG. 3—The mud house with thatch of palm leaves. In the chinks of such unsurfaced walls and in the thatch live the *barbeiros*. Southern Bahia.

The covering of the house is a more delicate and difficult problem. The fellah of Luxor may get along without any roof to his dwelling, but the *sertanejo* of Ceará, living in a land scourged by terrible droughts, must provide against occasional torrential rains. The thatch of palm leaves or grass, which we saw in Amazonas, is encountered on the very rudest type of mud huts in the outskirts of almost any village and on isolated dwellings in the forest everywhere; but the average Brazilian agricultural worker does better than that. He takes suitable clay from another pit, shapes it on a hollowed slab of wood, burns it in a simple kiln, and roofs his house with half-round tiles. These, like the mud of the walls, are supported on a wicker-work of saplings or on shakes split from a palm stem. The roofs of rural Brazil are usually two-sided and but slightly pitched, although four-sided roofs are not uncommon.

Trample down the earth over which this structure stands and you have an edifice which would delight a turtle: packed mud beneath, plastered mud around, burnt mud above. And no tool was necessary for its construction other than a jungle knife, the *facão* which every man owns.

Occasionally one sees whole villages where the dwellings are as miserable as that and are left in exactly that rough and unfinished condition.

In its simplest form, this rough house of mud will have but one room and a single door and window. Usually, however, there are partitions dividing it into at least three rooms; and, in all but the pitiful hovels of the most wretched, the walls are smoothed while wet. That is a simple thing—a

smooth, hard surface in place of a rough wall full of chinks and cracks. Yet the difference between the one and the other may be the difference between life and death, as we shall see directly.

As the wealth of the occupant increases, there come certain regular steps in attempted embellishment. The first is the application of a wash of color to the smoothed walls—frequently blue, or pink, or green, more commonly whitewash. A veranda, however narrow and however high the eaves, is always a real addition of comfort and somewhat breaks the harsh lines of the packing-box proportions; and when the owner simultaneously acquires

FIG. 4—Shows clearly the method of framing the mud house. Four uprights at the corners and two to support the ridgepole are the heaviest items in the construction. Aracanguá, in western São Paulo.

the capital and the energy to install a floor of wood, he has almost attained the ultimate goal.

That, from the threefold standpoint of beauty, hygiene, and utility, is attained in the use of tiles as a wall surface. Just why the use of tiles should be so much more common from Maceió north to São Luiz, the region once held by the Dutch, than in other parts of Brazil is not apparent. It is distinctly a legacy of the Moors in the Iberian Peninsula. Tiles as a wall covering and decoration have been especially used in the lands of Arab civilization, arid lands where dried mud forms an important constructional material. "Indeed it may be said that tilework is the most characteristic feature of Portuguese buildings." "Towards the end of the eighteenth century blue seems to have usurped the place of all other colors, and from that time, especially in or near Oporto, tiles were used to mask all the exterior rubble walls of houses and churches, even spires or bulbous domes being

sometimes so covered."[2] These blue tiles of Oporto are the prevailing fashion in house walls along the whole northeast coast of Brazil.

The addition of gilt pineapples, colored glass balls, fantastic waterspouts, pig-tailed corners, or birds of tile and mortar to the corners or ridgepole of a mud house piles horror upon horror. The ephemeral character of such habitations is their chief virtue, and one cannot be sorry that such unlovely excrescences do not endure as long, for instance, as the stone houses of the Breton peasant. In the mud villages of Brazil I suppose a house a quarter of a century old is a rarity.

But there is a kind of earth house which used to be much more common a hundred years ago than it is now, and some examples of this type have endured for upwards of two centuries. It is built on quite different principles and is altogether a more substantial structure. A form of planks, such as we use today in concrete work, is filled with earth, moistened and well tamped and gradually built up until massive structures two and three stories high have been reared. When the walls have thoroughly hardened they are pared smooth and tinted like the walls of the mud house. There are churches and monasteries in Brazil today which were constructed in this manner as long ago as the latter part of the seventeenth century.

Varying, then, between a one-room hovel with rough walls and a monastery with massive walls built up like the earthwork of a dam, enduring from two or three years to as many centuries but always reproducing itself, always remaining true to type, shaped both by tradition and by the natural environment, the mud house remains the sleep shelter of at least twenty millions of the humbler citizenship of Brazil. It is found from Amazonas to Rio Grande do Sul and from Pernambuco to the Bolivian border.

Unhygienic Nature of the Unsurfaced Mud Hut

If the rougher forms of the mud house have been characterized in some what uncomplimentary terms, it is through no lack of respect for the occupants, whose simple and generous hospitality the writer has so often enjoyed. At the same time there is good reason for condemning this hut which the illiterate millions of rural Brazil call home.

For it is the home, too, of the *barbeiro*, a house-inhabiting insect living only in the little chinks of the mud walls and within the thatch of *burity*—the bearer of the scourge called "Chagas' disease," *molestia de Chagas*. In speaking of the three great endemic diseases of Brazil Dr. Belisario Penna, the present chief of rural sanitation in the Brazilian Public Health Service, says:

> The most grave of all, because it is incurable, contracted in infancy, producing a high mortality, and generally disabling its victims, is Chagas' disease, the *doença do barbeiro*, which curses the population of more than seventy counties in Minas Geraes. I calculate

[2] W. C. Watson: Portuguese Architecture, London, 1908, pp. 28 and 22.

FIG. 5

FIG. 6

FIG. 5—The mud village. Showing how the mud houses are strung end to end on either side of the village street. On the Rio São Francisco, at Bom Jesus de Lapa, Bahia.

FIG. 6—A monastery of the type described by John Mawe, built of earth tamped into a form. This is the limit of earth houses in the directions both of size and durability. Such structures have lasted over two centuries.

that 25 per cent or more of the population of the state (Minas) is profoundly afflicted or rendered useless by this scourge. It exists throughout the state of Goyaz, in vast regions of Maranhão, Piauhy, Bahia, and Matto Grosso, and in some of the counties of São Paulo. . . . Deaths by the cardiac form occur in tremendous numbers in the infected zones, individuals dying through heart failure at all ages, even in full youth. The nervous form of Chagas' disease constitutes another aspect of extraordinary social importance. It includes those humans, monstrous in mentality and physical aspect, scattered through the interior of Brazil by the tens of thousands. . . .

Curral d'el Rey, whence the disease appeared, was but a background for goiters, cripples, and idiots—a tremendous breeding ground of the terrible *barbeiro*, there in the burrows, the dens, the mud-walled houses of the old inhabitants. These destroyed and substituted by attractive and hygienic habitations, both the insect and trypanosomiasis americana disappeared in all its forms. . . .

FIG. 7—One of the best types of rural brick-and-plaster houses. Verandas are conspicuous by their absence. Note the glass balls on the two corners. Although there is ample room to set the house back, it is almost always set flush with the street. Icó, Ceará.

Go to Sete Lagôas and Curvelho. In the residences of the well-to-do and those who live in houses covered with tiles, with smooth, whitewashed walls, neither the *barbeiro* nor the disease is encountered. Both are met in the suburbs where they tolerate the *cafúas*, the houses without plaster.[3]

The world of science is chiefly indebted to Dr. Carlos Chagas, the present head of Brazil's Department of Public Health, for identifying the malady with its cause. I have quoted his chief of rural sanitation thus at length because the disease is scarcely known outside of Brazil, and its cause still appreciated by few.[4]

[3] Conferencias, Rio de Janeiro, 1919, pp. 78–83.

[4] The disease is due to a trypanosoma—*Schizotrypanum Cruzi*—carried by *Triatoma megista* (of the family Reduviidae), locally known as the *barbeiro*. The disease appears to develop under rather special conditions, and its geographical distribution is restricted. Outside of Brazil it has been reported in two localities in Venezuela, in San Salvador, and in the eastern forests of Peru bordering on Brazil. Dr. Chagas' initial discovery was made while conducting an anti-malaria campaign in construction works on the central railroad of Brazil in 1907 under orders from Dr. Oswaldo Cruz of yellow fever fame. See M. Neveu-Lemaire: Notes de géographie médicale, section "Maladie de Chagas ou schizotrypanose américaine," *La Géographie*, Vol. 35, 1921, pp. 27–35.

Stone Houses

What a relief it is to come upon a locality here and there where the environment has caused a departure from mud in favor of stone! Diamantina, the center of the diamond district in Minas, lies on a high range of mountains which is almost bare of building timber, and for a dozen leagues round about even such slender poles as are used in the walls of the mud house are difficult to find. There is an abundance of excellent stone in the neighborhood, however, and all the older houses were built of this material. Many fine houses of two and three stories, constructed over a century ago in the days of prosperity, still adorn the town and grow lovelier with their increasing years. Unfortunately, since the railroad has been built, the tendency has been away from stone.

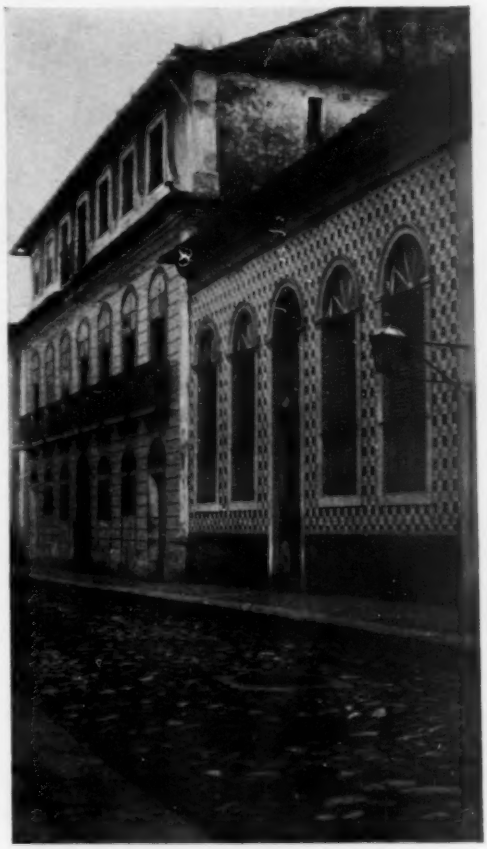

Fig. 8—Blue and white tiles used as a wall facing. The first (right) house appears to be built of pressed earth; the three-storied structure adjoining is undoubtedly of native soft brick. São Luiz, Maranhão.

Penedo, on the São Francisco River in Alagôas, is another stone town, built of the fine-grained, yellowish-colored sandstone on which the town stands. There must be others scattered here and there in this vast country, just as rare, isolated stone houses are seen—I encountered a temporary shelter of stone above timber line on the Serra do Caparaó on the boundary between Minas Geraes and Espirito Santo. But for the most part the Brazilian farmer, like the North American, shuns durable building materials as he would the plague.

Walls of Wattle

Now and again brush, woven into a rude wattlework, serves for the walls of dwellings like those hastily constructed at the edge of a great American construction camp in Ceará. Although it is better suited to a dry, hot country than is the mud house, in a belt of heavy rains it shelters its inmates

but indifferently. This type, wattle and thatch, is widely distributed but is not numerically important.

The Sod House

As the steppes of Russia have given birth to the *isba* built of turf, and the Great Plains of the United States to the sod house, so the pampas of Rio Grande do Sul have produced a similar hut. At rare intervals along the Uruguayan frontier, where timber is very scarce, one sees the shelter of some *gaucho* made by piling layer upon layer of sod from the plains whereon his cattle pasture. I have encountered this type nowhere else in Brazil, and it cannot be said to be at all common even in Rio Grande do Sul.

Fig. 9—The house of wattle has the advantage over the one of mud in that a space must be left between two houses of the former. On the edge of American construction camp at the Orós Dam, Ceará.

Houses of Wood

Just beyond Passo Fundo, traveling north through Rio Grande, one comes into the solid forest of Paraná pine (*Araucaria*) which clothes the plateau of Santa Catharina and Paraná. This is the region of the wooden house; and, as there are outliers of the forest along the watercourses to the southward of this point, so has the forest projected its wooden house upon the plains of Rio Grande. The sight of the first *gaucho's* cabin of slabs or boards with a shingled roof is enough to make one from the Great Lakes pinery gasp with delight. Rude, unlovely, without beauty of line or color, yet it appeals more than a palace after the monotony of mud to which we have grown accustomed, for it heralds our approach toward a forest folk who are beginning to utilize the wealth of their own environment. It is but an outpost of the lumber mills we are approaching, where there are many houses built not of slabs but of boards and siding, with trim doorways and window frames, steps of wood, verandas of wood, shingles on the roof, and sometimes even a coat of paint. If we entered, our feet would surely be greeted by boards on the floor. Our enthusiasm almost leads us to praise even the "gingerbread" embellishments produced, in Brazil as in North America, by a too facile fret saw.

FIG. 10

FIG. 11

FIG. 12

FIG. 10—A wooden house whose walls are made of round uprights planted in the ground. Matto Grosso.

FIG. 11—The second step in the evolution of the wooden house is to hew a face on the upright posts (center house); the third step is the use of split "shakes" placed vertically; the fourth step is the house of sawn boards used vertically, as in the house on the left.

FIG. 12—Practically all the buildings are of wood in the Paraná pine forests in the state of Santa Catharina.

Surely the music of a straight log driven on its carriage against a rapidly revolving saw is one of the finest sounds a heavily forested country like Brazil can hear. If a tenth part of the timber which has been burned to make the coffee plantations of São Paulo, the cacao plantations of Bahia, the fattening pastures of Minas, and the partial clearings of shifting agriculture everywhere had been manufactured into cheap lumber, every mud hut in Brazil could have been banished, along with the insects that infest them, and houses of wood erected in their place.

Not only in the forest region of Santa Catharina and Paraná is the house of lumber encountered, but likewise in the neighborhood of the sawmills which have been set up along the Rio Doce in Espirito Santo. Weathered walls of unpainted boards are the rule there, as in so many North American lumber towns. And not infrequently in this valley is seen a house with walls of shakes, short boards split from the log by hand and used in the wall vertically. Out in Matto Grosso round posts set side by side are used in much the same way to form the walls of more temporary shelters.

But in three years' wandering through Brazil I have never encountered a single example of that simplest type of wood house which the straight trunks of trees have suggested to forest dwellers everywhere in Europe and North America. The superposition of logs, either in the rough or squared, notched at the corners to form the walls of a log cabin, seems inherent in the physical character of the material. But because Brazil was settled by the Portuguese instead of by forest dwellers from the north of Europe, an obvious use for down timber never impressed itself on minds filled with other traditions. The log house can probably be found in out-of-the-way German or Polish colonies; but it must be described as an infrequent phenomenon in the forest regions of Brazil.

This infrequency is less astonishing than the general disregard of bamboo, which by all the peoples from Yokohama to Singapore and the islands of the South Seas is considered the God-given building material. Logs are heavy, and an isolated settler cannot place them even with the help of his wife and children; but bamboo is the lightest of all building materials. A Filipino with his *bolo* will build a house of bamboo, frame, floor, and walls, and thatch it with *nipa* quite as rapidly as the Brazilian builds his hut of mud. At the end, the Filipino has a thing of beauty, raised off the ground, cool, dry, with a floor of half-inch strips which springs under bare feet and can be polished with a banana peel; the Brazilian an ugly, unclean hovel which he shares with death-dealing insects. Yet bamboo will grow practically everywhere in Brazil and does grow profusely in many places now but is not utilized even for fish poles.

Houses of Brick

Before we speak in praise of the brick house it is just as well to point out that there are bricks and bricks. The ordinary, soft bricks of Brazil, of the color of the clay from which they are fashioned, with rough surfaces and

FIG. 13

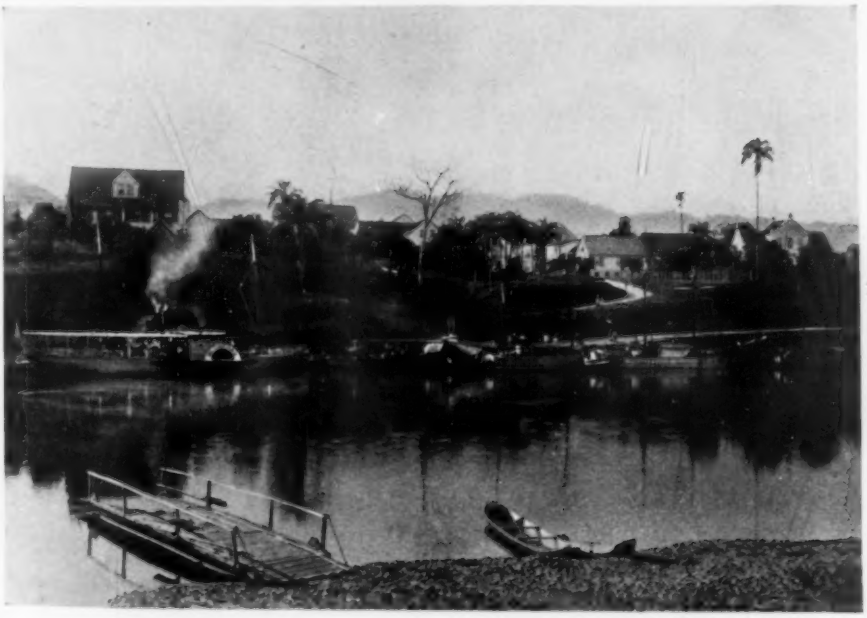

FIG. 14

FIG. 13—Typical farmhouse of the German Colonies in Santa Catharina: red brick of fine quality, timbering painted black, white sashes and door frames, and flat tiles, and note the *chimney!* It is not seen in most rural houses in Brazil.

FIG. 14—The town of Blumenau, a German settlement in Santa Catharina.

irregular edges, are only one degree better than the clay which is plastered into the squares of the mud house and allowed to dry in place. Like adobe, they always have to be disguised with a daub of clay or stucco or a facing of tiles; and it is easy to pass them by without distinguishing between the brick house and the better class of earth structures similarly finished.

When the traveler enters the German colonies in Santa Catharina it is almost as if he were transported to another land. What a difference the standards of a more exacting civilization have wrought! These industrious

FIG. 15—Santa Cruz, Espirito Santo. Grass-grown main street, path trodden by bare feet at right, white-washed mud houses built end to end and placed flush with the street. This is the type of thousands of little villages in rural Brazil.

peasants from the north of Europe started with the same materials that went into the mud hut—timber and clay, but the issue bears no faintest resemblance.[5] In the two thriving *municipios* of Joinville and Blumenau the timber is framed in attractive patterns that reveal structure and strength and adorn the exterior; the clay has been subjected to a mold and fire, nothing more complicated. Yet in the process it has taken on a gorgeous red hue together with durability and a hardness which no *barbeiro* can penetrate.

The tiles which cover it are molded flat, under pressure, giving as fine a roofing as the world affords. With a chimney to carry off the smoke of the kitchen fire, dark paint on the timbering, and a bit of bright color on window

[5] It is worth while to quote from Pierre Denis' "Brazil" (p. 299) on this point. "The Brazilian population, to judge from its dwellings, camps upon the land instead of residing on it. But the German colonists have brought to Brazil the love of a comfortable house, and each of their houses is a true home."

and door frames—the result, when set in a well-kept flower garden, is as attractive and substantial a type of farmhouse as can be found throughout Europe. I know no farming district in the United States where the houses are so uniformly pleasing as well as appropriate.

Brazil need look no further for one possible solution of its rural housing problem. The materials are found throughout the length and breadth of the land, and these hardworking Brazilians of Blumenau have shown splendidly how to use them. Indeed, the cities of Brazil might take a lesson from the farmers of Santa Catharina. The buildings which are being constructed today of soft bricks covered with stucco and a wash of color, however attractive when new, certainly will not bear comparison with the brick edifices of Blumenau half a century from now.

Such are Brazilian rural dwellings. Two types of habitations common in certain parts of the world are almost nonexistent: there is no cave-dwelling population in Brazil; and, aside from a few wandering gypsies and *vaqueiros* on the road with cattle, there are no tent dwellers.

The Rural Village

Lack of durability was the overwhelming impression which Spix and Martius had of the villages of rural Brazil a century ago at the end of the first extensive journey made in the interior by European scientists. Their picture of an average village in interior Brazil is as accurate in 1922 as it was in 1822. One entirely misses the appearance of comfort and solidity calculated for long duration which distinguishes European dwellings.

"Like house, like village." If the human habitation is frail and low, it is difficult for the village to appear anything but ephemeral and mean. The custom of stringing one-storied mud houses end to end along both sides of a narrow street simply magnifies ugliness many fold. Why do we find such crowding in the country where of all spots on the globe there is land enough for every one and to spare? It is a characteristic of the Mediterranean type of village described by Brunhes:

> Almost all the Mediterranean peoples, preëminently "urban," have grouped themselves in settlements with houses closely crowded together, so closely that they have the appearance of small cities even when they are only simple villages. A life concentrated around the public square . . . , around the bastion or stronghold, the temple or the church, is preëminently a life of house close against house.[6]

Here again, tradition is fortified by environment. Brazil is as yet so underpopulated, so much of life is spent in appalling solitudes, in traversing almost uninhabited *campos* and *caatingas* for weeks on end, in pushing a canoe through watery wastes where the sun seldom enters and men chant aloud as they paddle to lighten the oppressive weight of the silence. The village was built for companionship, for human warmth.

[6] Jean Brunhes: Human Geography, transl. by T. C. LeCompte, edit. by Isaiah Bowman and R. E. Dodge, Chicago and New York, 1920, p. 503.

"Why set my house in the middle of a garden when I can build so near my friend, João, that I can counsel with him about cattle and crops without getting out of my hammock?

"Why set my house back from the street where *tropas* pass with their tinkling bells, and the chant of the *vaqueiro* precedes the rumble of hoofs of the *boiada*?

"God knows there is enough of silence and loneliness in the *sertão*!"

THE ORIGIN AND GROWTH OF PARIS

By Lucien Gallois
University of Paris

Paris makes its earliest appearance in history a half century before the Christian era during the Roman conquest of Gaul. It is in the *De bello Gallico* that Caesar makes the first reference to the Parisii and their capital Lutetia.

The Parisii were a small tribe whose forest-encircled domain was of much less extent than that of their powerful neighbors of Chartres, Beauvais, Sens, or Rheims. As to Lutetia, the capital, it was confined to an island in the Seine. Certainly no one could then have foreseen that it would become one of the world's great cities.

It has been said, it is true, that Paris occupies a situation that was destined sooner or later to give birth to a great town. Paris has been called the "attractive pole of France." It is always easy to predict after the event. A town, however, is the work of man rather than of nature. That the position of Paris offers advantages is easily demonstrated. Yet at the same time historical events and economic facts have had their influence on its development. Let us study first the physical "*milieu*" in which Paris has grown, the surrounding region, and the site of the town itself and then follow its destinies across twenty centuries of history to the present day.

The Parisian Region

Paris occupies the center of a great natural region appropriately known as the Paris basin. This region is surrounded by uplands and highlands of moderate elevation—the Ardennes to the north, the Vosges to the east, the Central Massif to the south, the hills of Normandy to the west. Rivers converge towards the center of the vast basin-shaped hollow. Even the Loire trends in this direction as far as Orléans. Here, consequent on a movement of depression in late geological time, the Loire makes an abrupt turn towards the west. But though there is no connecting valley the Paris basin is only separated from the Loire at Orléans by an almost level plateau which offers no obstacle to communications. The lines of concentric heights which rise to the east of the basin are all breached by rivers, and along them go the roads.[1] In all parts of the basin, by valley or plateau, roads and subsequently railways have been constructed with ease and a minimum of grade that permits most economical conditions of transportation.

Furthermore, the Paris basin has easy communications with neighboring

[1] For a brief study of the Paris basin I cannot do better than recommend to the reader Professor W. M. Davis' little book "A Handbook of Northern France," Cambridge, Mass., 1918.

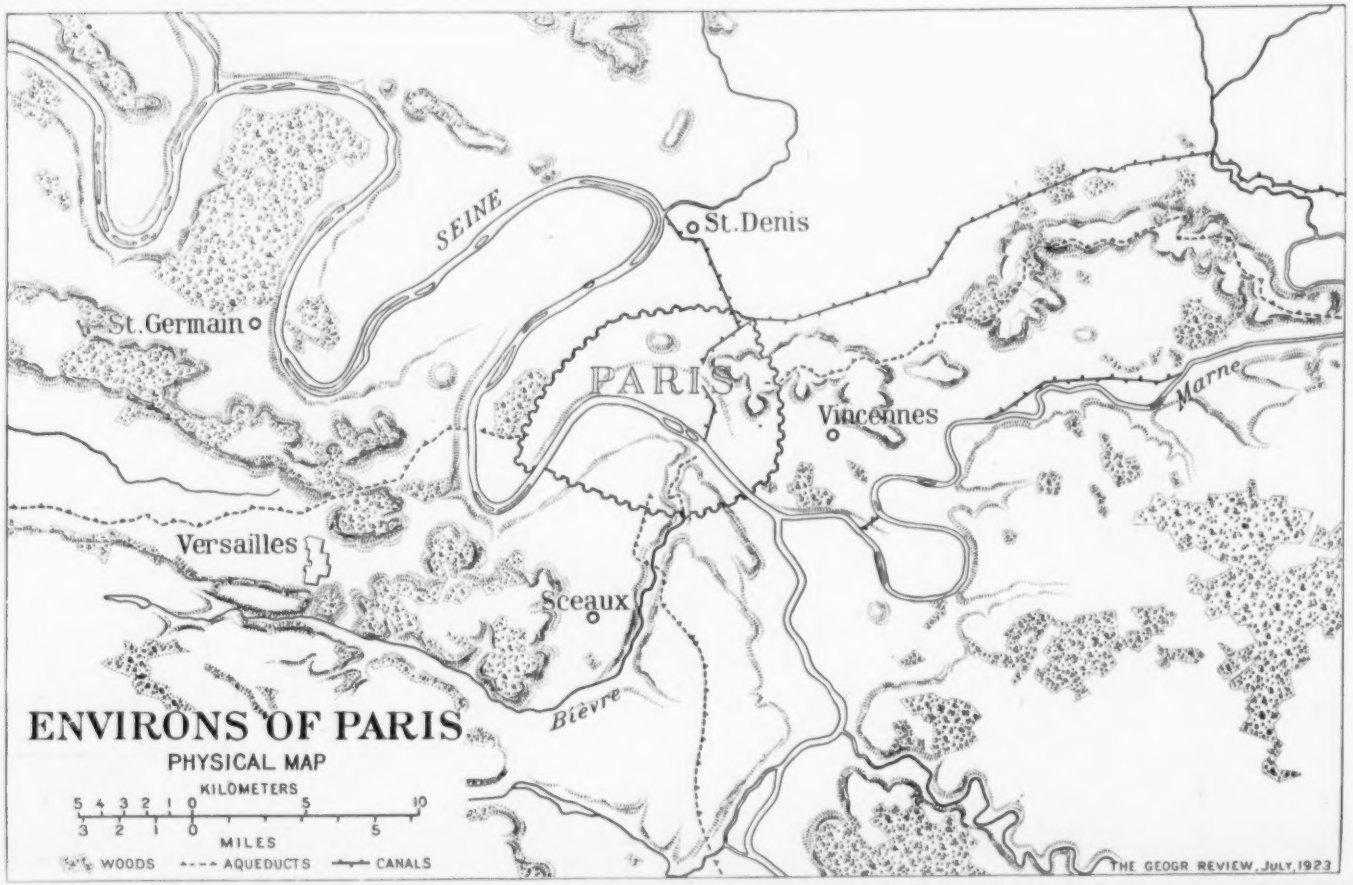

FIG. 1—Physical map of the surroundings of Paris. Scale approximately 1: 333,000.

regions. No barrier separates it from Belgium to the north or Alsace and the valley of the Rhine to the east; for the mountainous massif of the Hautes-Vosges is easily turned by the depression inappropriately termed the "col" of Saverne on the north, and on the south by the broad gap of Belfort appropriately known as the Burgundian gate which separates the Vosges from the Jura. Towards the Saône-Rhone valley there is no important obstacle, connection being readily made by the gap of Langres or more directly across the heights above Dijon where a single tunnel gives access to the railway. As has been said, communication is easy with the valley of the Loire whence one passes by the broad saddle of Poitou into the valley of the Garonne.

So facile are these connections that they have been readily extended by the canals that now link up the rivers, Seine and Scheldt by the Oise, Seine and Rhine by the Marne, Seine and Saône, Seine and Loire. Paris has thus become the center of a great network of waterways, roads, and railways, a system perfectly adapted to the natural conditions. But this system has only developed as the city has grown. In the first instance there had to arise the need of a convergence of roads at some specific point in the region. This is clearly shown by the course of historical events. When Gaul was a dependency of Rome it was on Lyons that the network of routes converged, because Lyons, in easy communication with Italy, was the point of support for Roman power in Gaul and, as it were, the capital of the country.

The convergence of valleys and rivers is the most salient feature of the geography of the Paris basin. The Marne joins the Seine at the very gates of Paris; some ~~20 kilometers~~ to the west is the confluence of the Oise. But not only this: due weight must also be given to the navigability of these streams of tranquil and steady flow. That navigation on the Seine and its tributaries commenced at an early date is certain. Caesar speaks of the numerous boats encountered on the Seine in the neighborhood of Paris; and the geographer Strabo, a century after the conquest, mentions the importance of the waterways which crossed Gaul by the Rhone, Saône, and, after a short interruption, by the Seine or Loire.

Between the rivers which converge on Paris lie interstream areas of great fertility. Covered in large part by loams they are grain lands "*par excellence.*" At a time when a region had to be largely self-supporting there was sustenance here for a numerous population. Paris was fed chiefly on the wheat grown in the Île de France, the region between the Seine and the Oise which first bore this name. By way of Rouen came salt from the seaboard, by the Yonne wood was floated down from the forests of Morvan. But these advantages must not be exaggerated. Many towns, Berlin for example, have flourished in regions impoverished as regards natural resources. At the same time to have at hand all the prime necessities of life was an evident cause of prosperity, especially in ancient times. Productivity of the soil was also favored by a climate generally mild and with regularly distributed

FIG. 1.—Physical map of the surroundings of Paris. Scale approximately 1:333,000.

and sufficient rains. Furthermore, the summers of this tempered climate were yet warm enough for grapes and various other fruits to ripen. Once all the neighboring hillsides were clad with vineyards. They only disappeared when improved transport permitted the sale of wines from the Midi at a low price.

Another factor which, while not indispensable, yet aided the growth and at the same time the adornment of the town was the presence of good building materials. From the neighborhood of Paris is quarried a very fine limestone easy to work and well adapted to sculpture, which has served in the building of the beautiful churches of the Île de France and the greater number of the monuments of Paris. Certainly the existence of such material has not been without influence on the precocious flowering of architectural art in the Parisian region. This limestone has long been quarried in Paris itself, on the left bank of the Seine. In certain sections the course of the ancient workings may be traced by subsidences of the ground to which they have given rise in the past and occasionally cause even now. Since the end of the eighteenth century a special engineering service has been engaged in making the area secure and has drawn up a plan of subterranean Paris. These abandoned galleries are often known as the Catacombs, because for the last century skeletal remains from the old Parisian cemeteries have been deposited therein.

Another building material occurring in abundance is gypsum, quarried on the slopes of the hills to the north of Paris up to the city itself. At an early date gypsum was employed in the manufacture of the plaster so much used throughout the Parisian region. Mention should also be made of the clay which outcrops in many places and is used in pottery and tile making. On the site of the old tile works next the Louvre the palace of the Tuileries, now destroyed, was erected. Once again, however, we must insist that it would be puerile to try to explain Paris by the abundance of building materials; but that fact has at least contributed to give the town its physiognomy and its architectural aspect.

The Site of Paris

But all this, one may say, applies to the region of which Paris is the center and is not peculiar to the particular corner of earth on which Paris arose. Why was this particular spot chosen, and not a site farther upstream or downstream? Why on the Seine and not on the Marne or the Oise? Or more exactly why, among the several settlements that existed on the banks of these rivers, Meaux on the Marne, Melun and Corbeil and Poissy on the Seine, Pontoise on the Oise, has Paris drawn to itself a great population while these other places have only risen to the rank of small towns? In answering this question it is not the Paris of today that we must consider nor even the town when it had already grown to a recognizable aspect, but the humble collection of huts that was its origin. The site of the primitive

settlement, as it has been reconstructed by the aid of patient researches, must be examined more closely.

Paris is situated at a broadening of the valley of the Seine, a place where the river runs over ~~softer~~ rocks than above or below and thus has eroded them more easily. To the south, on the left bank, fronting the Île de la Cité is the hill to which has been given the rather ambitious name of Montagne Ste. Geneviève, the edge of the plateau in which the valley has been cut. But to the north, or on the right bank, there remain only fragments. One

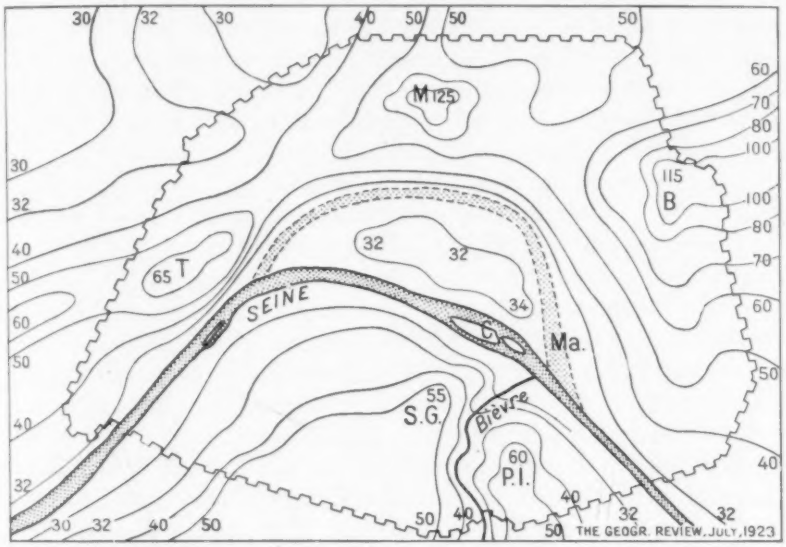

FIG. 2—Topographic relief of Paris, altitudes in meters. Former arm of the Seine in dashed lines. B, Belleville; C, Cité; M, Montmartre; Ma., Marais; P. I., Place d'Italie; S. G., Mont. Ste. Geneviève; T, Trocadéro.

of these is Montmartre, an isolated hill rising to an elevation of 125 meters, or 100 meters above the level of the Seine; farther east and stretching to the Marne are more extensive fragments, the heights of Ménilmontant and of Belleville. The two broad gateways that open one side and the other from Montmartre furnish an easy passage towards the north.

Obviously this enlargement of the valley offers a site favorable to the establishment of a large town. Furthermore, there is a marked diminution of the river gradient in the neighborhood of Paris where the Seine is not more than ~~26 meters~~ in mean elevation above sea level. This is the reason for the great, symmetrical meanders which the river describes in its course below the city. Decrease of gradient and slackening of the current naturally caused deposition of alluvial material brought from upstream, especially of the granitic sands brought from Morvan by the Yonne. Thus are explained the islands which formerly encumbered the bed of the river. Only two of them remain today, the Île de la Cité and immediately upstream from

it the Île Saint Louis. The others were attached to the mainland in the nineteenth century.[2] These low islands were constantly menaced by inundation from the river floods. The Cité was then also much lower than it now is and was not of course embanked by quays as it is today. Upstream and down the low, indefinite banks were cut in places by side channels. One of these arms on the left bank opposite the site of the Louvre enclosed a more stable piece of ground where today stands the church of St. Germain des Prés.

A topographic map of the reconstructed site reveals the existence of an old channel to the north of the present bed at some distance from the foot of the hills of Ménilmontant and Montmartre. This old arm describes a curve which the river is no longer able to follow. Its course is still clearly discernible from the vicinity of the Place de la Bastille to the foot of the Trocadéro hill. Several times during great floods the Seine has just failed to return to this old channel. It was indeed invaded to some extent by infiltering waters during the flood of 1910. Historical documents confirm what topography teaches. In the Middle Ages there still existed a marshy belt stretching upstream from the Place de la Bastille and occupying the quarter still known as the Marais. This marsh area was not drained until the twelfth century, before which time the roads leaving Paris in north, northeast, and northwesterly directions crossed it by bridges. All the low area to the north of the Seine offered little attraction to human settlement. It took centuries for Paris to grow in this direction.

But to return to our question, why was the settlement of Lutetia founded at this point in an island of the Seine? Without doubt because of the comparatively easy river crossing here afforded. For travelers coming from the south the Montagne Ste. Geneviève formed a sort of elevated causeway leading down towards the Seine. At this place the ground was firmer than immediately above, about the confluence of the Bièvre, or below, in the meadows of St. Germain des Prés. After the island had been crossed, the road could be taken up again on the sandy bluffs where are now the church of St. Gervais and the tower of St. Jacques. A little island facilitating a river crossing—there is the humble origin of the hamlet that became Paris. At first it was nothing more than a settlement of fishers and boatmen. But the site had sufficient attractions to fix there a small nucleus. Other advantages appeared only later with the expanding horizon of the town. And these advantages were only attained by conquest. The wooded plateaus had to be cleared and cultivation started; the marshy soil of the right bank had to be drained; and later, roads, railroads, and canals had to be built. It was also necessary to improve navigation on the rivers, without doubt one of the greatest natural resources of the early settlement but not adapted to the demands of modern navigation.

It is clearly seen from such an example as this, that nature merely furnishes

[2] There is today a third island, the Île aux Cygnes, on which has been erected a reduced copy of the Statue of Liberty at the entrance to the port of New York. But this is an artificial island.

man with possibilities. He must put them to profit and adapt them to his use in the face of events of which he is not always the master. This will be seen still better in the following brief glance at the history of Paris.

Gallic and Gallo-Roman Paris

On the eve of the Roman conquest the little settlement of Lutetia had already achieved a certain degree of importance, for it was the chief town

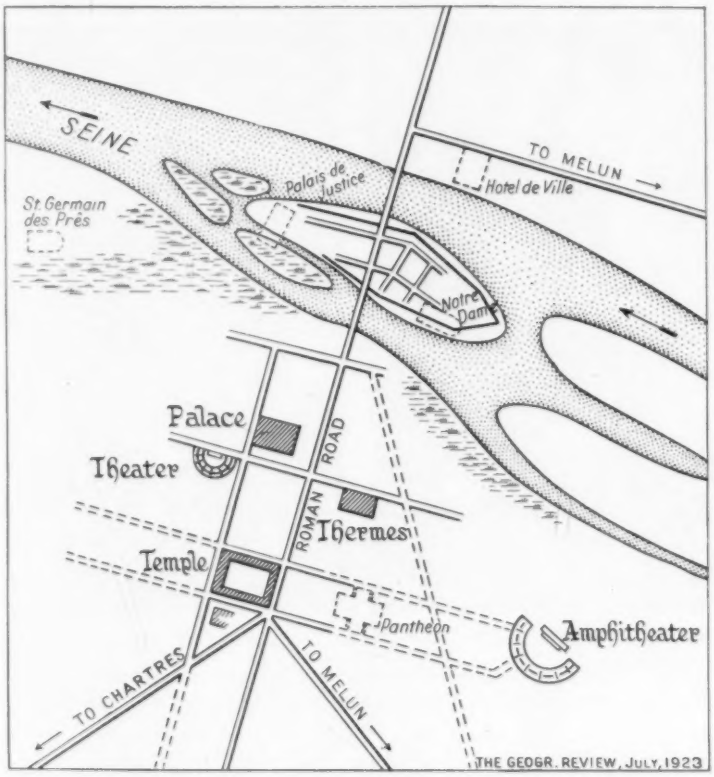

FIG. 3—Plan of Gallo-Roman Paris after F.-G. de Pachtère (Paris à l'époque ga lo-romaine, Histoire générale de Paris, Coll. de Documents publiée sous les auspices de l'édilité parisienne, Paris, 1912). For purposes of orientation some modern sites have been shown with names in hair-line italics.

of the Parisii. We know from Caesar that two bridges connected it with the two banks and that these bridges were destroyed by the Gauls to impede the passage of the invading Roman army encamped on the bank of the river.

The Parisii, like other Gallic tribes, did not long hold enmity against their conquerors. They quickly submitted to the Roman aegis and the peace which it assured. It was thus that Gaul was opened to Mediterranean civilization and received the Latin impress. One knows with what readiness

the Gauls gave up their Celtic speech and adopted the Latin tongue from which modern French has descended.

A Roman town arose opposite the Cité on the hill on the left bank of the river. It had all the usual buildings to be found in Roman or Romanized towns, including a theater, arenas, and baths. Water for the baths was brought from the neighboring plateaus by an aqueduct which crossed the valley of the Bièvre. During the first three centuries of our era the Roman town on the hill must have been a pleasant place with its villas enveloped

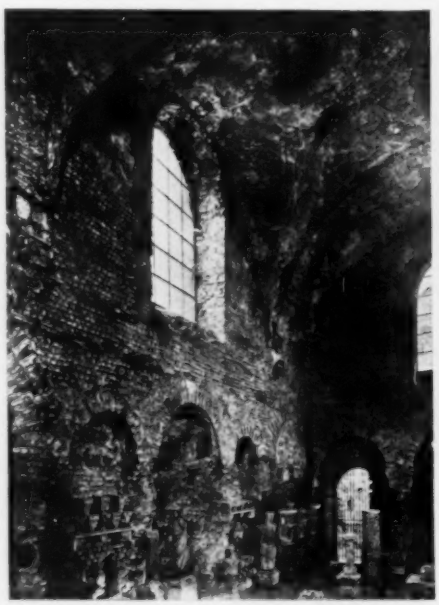

FIG. 4

FIG. 5

FIGS. 4 and 5—Remains of Gallo-Roman Paris. The great hall of the so-called Palais des Thermes now included within the Musée de Cluny. After a photograph from F.-G. de Pachtère (see Fig. 3).

in gardens and vineyards. A Roman road, doubtless replacing an older Gallic track, crossed it coming from the south and led to the bridge to the Cité. Another bridge carried it to the right bank whence it divided, one branch going upstream, another down. Two of our modern streets still mark its route, rue St. Jacques on the left bank, rue St. Martin on the right. They are the most ancient streets of Paris.

Of Gallo-Roman Paris there remain today only the buildings adjacent to the Cluny Museum, incorrectly known as the Thermes, and the recently excavated arenas. It must be admitted that they are in no wise comparable to the fine ruins of Arles or Nîmes. Roman Lutetia was certainly not a great city. From this period there dates an interesting inscription, the oldest that has been excavated in Paris. It occurs on a little monument erected to Jupiter in the reign of the Emperor Tiberius by the corporation of

Parisian boatmen. Tiberius reigned in the first century of the Christian era, but the corporation was doubtless older. In time it became one of the richest corporations of the city, and from it developed the municipality.

Barbarian invasions at the end of the third century destroyed this luxurious town on the left bank of the Seine. With the débris of its buildings the Parisii for the first time surrounded their island with defensive walls. A Roman garrison was stationed there, and military chiefs were in residence. One of them, Julian, was there proclaimed Emperor by his soldiery. Of the little town he has left a description which testifies to the charm it had for him: "I was," he says, "in winter quarters in my dear Lutetia. It is quite a small island, enclosed within encircling ramparts and approached only by two wooden bridges. The river which surrounds it is tranquil and steady-flowing. It is agreeable to contemplate its limpid waters, which, furthermore, are good for drinking and are used for this purpose by the inhabitants. The winter is not severe; the climate is sufficiently mild for the cultivation of fine vines and even figs, though these latter must be protected by straw coverings against the winter cold." This last curious detail is perfectly exact.

But the Roman forces could not resist the pressure of the barbarians. Paris ultimately fell into their hands, though how or when is not known. On the other hand Christianity was introduced, and its impress replaced that of Rome. A new epoch commenced with the fifth century. The name Lutetia disappeared and was succeeded by that of the people who occupied it.

Paris at the Beginning of the Middle Ages

At the beginning of the sixth century one of the Frankish chiefs, Clovis, had attained practical mastery over all Gaul. Under the influence of his wife Clotilde he was converted to Christianity, less however by conviction than by the hope of advantages to be gained from the favor of the bishops. In the last years of his life he installed himself in Paris, where he could readily keep watch over conquered provinces north and south of the Seine. There he died and was buried, and his wife Clotilde also, in the church he had built on the summit of Mont Ste. Geneviève.

This pious foundation was the forerunner of many similar ones, churches and abbeys. The best known are those of St. Germain des Prés, on the left bank of the Seine, and St. Denis, on the right bank but in the present suburb of that name. St. Denis dates from the seventh century and later became the burial place of the kings of France. Round these religious edifices and under their protection settlers established themselves and took up cultivation. Both churches thus became the center of distinct agglomerations which in time expanded and approached until now their union is complete. One of the Frankish kings of the seventh century established for the benefit of the abbey of St. Denis a great annual market which acquired a fame similar to that of the celebrated fairs of Champagne. It was thus that Paris benefited from its facilities of access.

But all this prosperity was threatened in the ninth century by a return of barbarism. Northern pirates coming by sea arrived at the mouth of the Seine. They seized and sacked Rouen, whence their flotillas ascended the river. Everywhere the terror-stricken populace fled before them. The monasteries hastened to carry away to safety the relics of the saints. For a time the Normans were halted before Paris by a payment of gold, but later they returned and took the town. When they left, the inhabitants rebuilt their walls and thirty years later victoriously resisted another assault. But all the surrounding country was devastated, and its inhabitants were forced to seek refuge within the town.

FIG. 6—The Pont au Change. After a miniature in a manuscript of the Légende de Saint Denis, commenced in the fourteenth century (Bibliothèque Nationale de Paris, fonds français, 2090). In the middle of the bridge a fortified gate; on the bridge, passers-by and shops. Above, are presentation of Saint Denis preaching.

We are now in the tenth century, and the primacy of Paris is not yet established. But we are on the eve of an event of great consequence for the town; the ascent of the Capet princes to the throne of France.

PARIS, CAPITAL OF FRANCE

The treaty of Verdun in 843 had put to an end Charlemagne's attempt to restore the Roman Empire of the west. By this treaty a threefold division of territory was made, the westernmost portion becoming the kingdom of the Franks or France. But the authority of these first kings of France was precarious. The feudal régime had almost entirely destroyed any form of centralization. Every baron was to all intents and purposes independent in his own domain. For a century the Carlovingians reigned ingloriously enough; then (987) the feudal chiefs chose for king the scion of another house, Hugh Capet, whose father and grandfather had distinguished themselves in the struggles with the Normans. These Capetians had their own domain, which extended from the Loire to the north of Paris. But, contrary to the usual belief, they had only a nominal hold over Paris, where they rarely resided, although they had a palace at the western end of the Cité on the site of the Palais de Justice. The true master of Paris was the

bishop, who held the fief of the County of Paris. It took a century and a half for the Capetian kings to establish their authority in the region, and it was only at the commencement of the twelfth century that Paris became the real capital of the kingdom. The Capet kings had made France. Round their own domain, patiently during centuries they had consolidated the French provinces, united northern and southern France, made their authority everywhere respected, and extended their government. This must all be recognized if one is to understand the importance which Paris assumed in the kingdom. It grew as the royal authority grew.

We have enough contemporary documents to furnish a picture of this Paris of the twelfth century. The real city is still that of the Cité with its

FIG. 7—The Place de Grève and the old Hôtel de Ville (Arcade St. Jean) to the left. Beyond the Seine is the Île de la Cité. The scene represents a procession of monks and soldiers at the time of the League (Catholic against the Huguenots). From a painting by Porbus (sixteenth century) in the Château de Valençay.

narrow streets, its numerous churches, its cathedral of Notre Dame, the building of which was begun in the second half of the century, and in its vicinity the palace of the bishops, the dwelling of the priests, the cloister of Notre Dame, already famous for its schools and early ancestor of the University of Paris.

Still only two bridges connected the Cité with the river banks; but that to the right bank had been replaced by one a little farther downstream opposite the road leading to St. Denis (present rue St. Denis). The bridges were the scene of great animation, lined as they were with the houses and shops of merchants, while below and almost obstructing the arches were water mills or fish ponds. The right bank where the boats anchored carried the bulk of the traffic, and here was established a market the site of which is still occupied by the Halles Centrales. It was now on this side that Paris grew. But there were still many empty spaces and patches of cultivated land. The left bank was less occupied. In the midst of gardens and vineyards were several churches around which houses had grouped themselves.

Paris was becoming a great city. Its population—of which, however, it is impossible to give a figure—must have been large for the time. It included nobility, royal officials, clergy, artisans, merchants, tillers of the soil, and vinegrowers; and one must not forget the students gathered round the schools of Notre Dame, some of whom even then came from distant countries. Paris of the twelfth century was becoming a center of civilization.

FIG. 8—Panoramic view of Paris at the beginning of the seventeenth century (1607) by Léonard Gaultier. The view is seen from the south (left bank of the Seine). In the center, the Île de la Cité with Notre Dame is still the only inhabited island. In the background the hill of Montmartre to the left and the heights of Ménilmontant and of Belleville to the right, crowned with windmills.

To assure the defense of the city King Philip Augustus decided to enclose it within a wall furnished with towers and fortified gates. It enclosed on the left bank the part of Mont Ste. Geneviève which fronts the Seine and on the right bank the old quarters about the present markets and the Hôtel de Ville. It left outside the Louvre, or, speaking more exactly, the fortress and prison which antedated the palace of that name. This wall was built in the latter part of the twelfth and the beginning of the thirteenth century. For long the section on the left bank remained unchanged. Here in the thirteenth century were built many colleges for the accommodation of the poor scholars eager for learning who were drawn in increasingly great numbers to the Paris schools. It was the period when such illustri-

ous foreigners as the Italians St. Bonaventura and St. Thomas Aquinas, the German Albertus Magnus, the Englishman Alexander of Hales came as teachers to the banks of the Seine. One of these colleges, founded in 1257 by Robert of Sorbon, gave its name to the Sorbonne, which today accommodates a part of the University of Paris. For the future the left bank became the student quarter, effervescent at times but a cradle and home of science.

FIG. 9—The Grands Boulevards at the beginning of the nineteenth century. The building to the right is the "Bains Chinois" which gave their name to this part of the boulevard. After a sketch by Bacler d'Abbé, lithographed in "Promenades pittoresque et lithographies dans Paris et ses environs," Paris, 1822.

It was, however, chiefly on the right bank that Paris continued to grow. In the fourteenth century under King Charles V the city was encompassed by a new wall, concentric with the old one, and defended at intervals by bastion towers, the "Bastilles." One of the stoutest of these on the site of the present Place de la Bastille survived until the end of the eighteenth century when its fall at the hands of the people on July 14, 1789, marked the beginning of the French Revolution. The new wall from the northeast side followed the course of the old arm of the Seine deviating to the northwest to approach the river and this time including the chateau of the Louvre built under Charles V in place of the old fortress. Paris was by this time a populous city. A census made in 1329, before the building of the new wall, enumerated 61,098 "hearths," that is to say families or households, corresponding to about 290,000 individuals at least. And yet on vacant areas within the new wall building continued apace. (Fig. 10).

Paris from the Sixteenth to the Nineteenth Century

The wars and turbulences of the fifteenth century retarded the growth of Paris, and need for a new expansion of the wall did not arise until the sixteenth century. This extension, which dates from the reign of Francis I

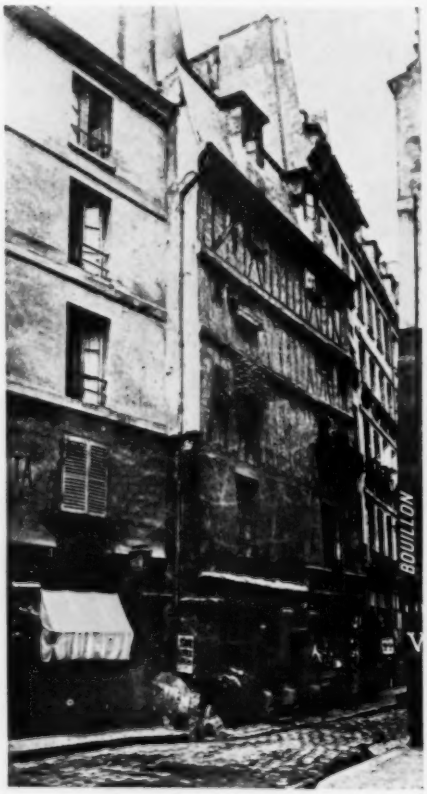

Fig. 10

Fig. 11

Fig. 10—Old Paris. The rue Volta (3rd arrondissement). Very old timber-framed house. Collections de la Bibliothèque de la Ville de Paris.

Fig. 11—Old Paris. The rue Brise-Miche (4th arrondissement). Collections de la Bibliothèque de la Ville de Paris.

(1515–1547), affected only the northwestern section on the right bank of the river. Under Louis XIV a new advance on the same side was made in the seventeenth century, and this time the Tuileries palace was enclosed. Within this old wall already lived 500,000 inhabitants, close pressed in the narrow streets lined by tall houses examples of which are still in existence. In spite of the monuments and sumptuous mansions which had been raised in vacant places and without the walls, the Paris of Louis XIV still kept its medieval aspect. But the city continued to grow, and the wall, overrun

on all sides, lost its military value. The useless rampart was now transformed into a tree-bordered promenade. This is the origin of the Grands Boulevards —the inner boulevards.

Another extension was made at the end of the eighteenth century, but this time with a fiscal aim. A customs barrier was erected to facilitate payment of the octroi. It took the form of a wall continuous on both banks and well without the old wall. This was the wall of the farmers-general of taxes. Its emplacement is today marked by the outer boulevards. But this wall extended far beyond the city proper and enclosed a broad extent of gardens and cultivations.

We are now on the threshold of the nineteenth century, and henceforth progress becomes more and more rapid. About the wall of the farmers-general, which had seemed much too large in circumference, new suburbs appear and villages grow.

Successive censuses now permit us to measure the regular increase of the population. In 1789, 524,000 people; in 1801, 547,000; in 1817, 713,000; in 1841, 935,000. In 1840 it was decided to surround Paris by a double ring of defenses—a fortified enceinte and a series of detached forts. The enceinte enclosed not less than eleven suburban communes which did not then form part of the city but were incorporated in 1860. In consequence the census of 1861 showed the enormous increase to 1,690,000 inhabitants. The enceinte, its grass-covered ramparts overlooking a deep moat, became a real boundary for the growing town. Without it for a breadth of 200 meters the erection of dwellings, save wooden huts which could speedily be demolished, was prohibited that the defense might not be embarrassed. This belt, known as the "Zone," was invaded by a population mostly of poor folk whose small gardens gave to it an illusive look of the country.

Modern Paris

The date 1860 corresponds approximately to the beginning of a new period, the contemporary period. Since then the population has not ceased growing. In 1872 it was 1,851,000; in 1881, 2,269,000; in 1891, 2,447,000; in 1901, 2,714,000; in 1911, 2,888,000; in 1921, 2,906,472. The smallness of the last increase, 18,000, is due not only to the enormous losses caused by the war but also to the exodus of the population to the suburbs.

This exodus is itself the result of the continued development of means of transportation. The great transformation dates from the middle of the last century with the completion of the great railway lines. In 1856 all the lines setting out from Paris reached their termini. At this time the numerous small companies which had been formed at the beginning fused into six distinct systems. Five of these have their point of departure in Paris; the western system (Paris to Brest and Havre), northern (Paris to the Belgian frontier), eastern (Paris to Strasbourg and Basle), Paris to Lyons and the Mediterranean, Paris to Orléans (prolonged to Bordeaux).

Naturally it is in the quarters on the outskirts where more free space was available that the railroad stations have been built. While the process of obtaining adequate ground for the great terminal stations was under way it was decided at the same time to put into operation long projected plans for opening up the old quarters of the city. To this rebuilding and beautifying of Paris, work which lasted through the reign of Napoleon III (1852–1870), the name of the prefect Haussmann is attached. The narrow streets and alleys blocking the views of such monuments as the Louvre, the Pantheon, and Notre Dame were removed. Fine perspectives were opened up everywhere. Broad tree-lined avenues were run in straight lines from old Paris across the newly incorporated quarters. But still today close at hand much of the old aspect survives. Near the tall houses of six or seven stories that line the new roads are narrow, crooked streets; and on the hills of Ménilmontant and Belleville one can still see little rustic cottages in the midst of gardens. In the new quarters fine parks have been laid out, as at Buttes-Chaumont where the old plaster quarries have been turned into pseudo-natural grottoes. Transformation has been continuous since 1870. Completion was only retarded by the war, and already plans are under way for the beautifying of greater Paris.

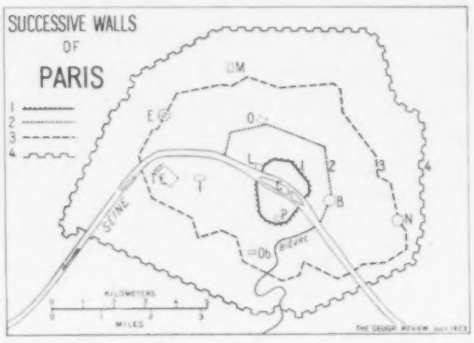

FIG. 12—Successive walls of Paris. 1, wall of Philip Augustus, thirteenth century; 2, wall at time of Louis XIV, seventeenth century; 3, wall of 1789; 4, wall of 1840; B, Place de la Bastille; C, Cité; E, Place de l'Étoile; I, Invalides; L, Louvre; M, Montmartre; N, Place de la Nation; O, Opéra; Ob, Observatory; P, Panthéon; TE, Eiffel Tower.

The building of railroads had other consequences for Paris than those described above. It permitted the easy carriage of coal from the mines of the Nord. Before this Paris engaged little in industry, mostly in home industries whose success depended upon the skill and taste of the workman. Now factories proper have been installed, most of them in the suburbs. The railroads, however, are not the only contributors to the coal supply. In an earlier number of the *Geographical Review*[3] was shown the debt Paris owed to river navigation. and the magnitude this has assumed today. Thanks to such facilities Paris has also become a great commercial center, the great permanent market of France. Before the war, excluding building materials and coal, Paris exported as much merchandise as she imported. This multiplication of industries and growing commercial activity has been the determining cause of the afflux of people into the city from other parts of France and from abroad.

But the population of Paris no longer crowds itself as before into the

[3] Albert Demangeon: The Port of Paris, *Geogr. Rev.*, Vol. 10, 1920, pp. 277–296.

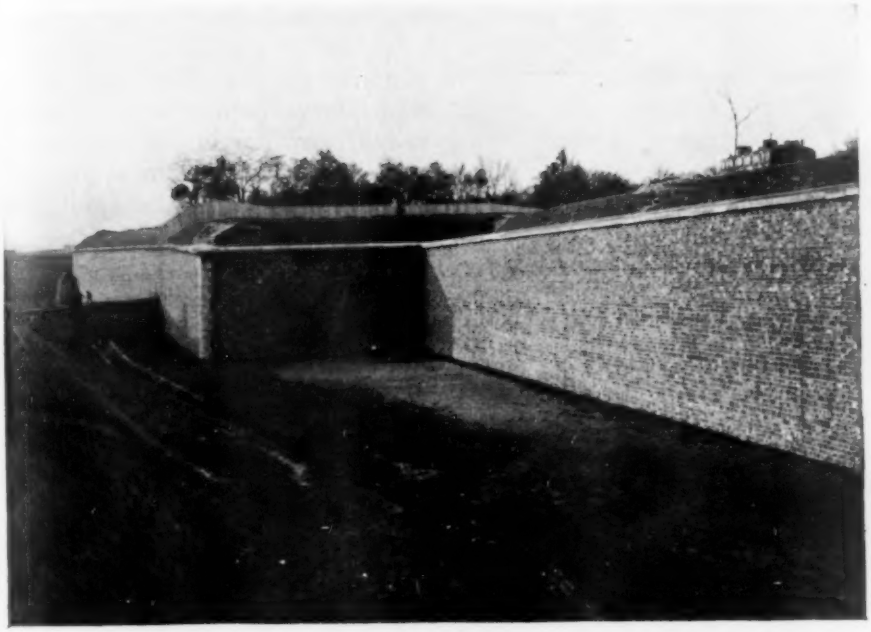

FIG. 13

FIG. 14

FIG. 13—The wall of the fortifications of Paris now in process of demolition.

FIG. 14—View in the "Zone," the 200-meter broad space in front of the fortifications where the erection of permanent buildings was prohibited for military reasons. The Zone will disappear as the fortifications are destroyed.

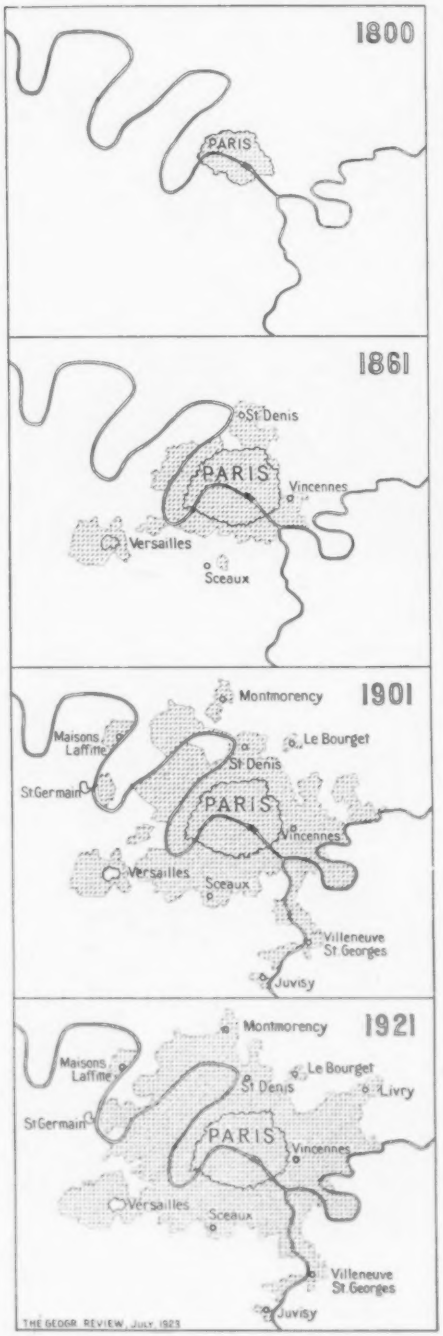

FIG. 15—The growth of Paris and its environs. The shaded areas have at least 10 inhabitants to the hectare. (The first three figures after L. Bonnier in *La Vie Urbaine*, Vol. 1, 1919, pp. 7–76.)

center of the city. The broad spaces which have been cleared to make way for new streets, the increasingly great space occupied by stores and offices have pushed the population towards the outskirts where there is more room. The center of Paris, like the center of London, is becoming a city of work but not of residence. The exodus towards the outskirts has necessitated the creation of a multifold system of transportation—omnibuses, horse-drawn at first, now automotive, tramways, and subways—which in turn has still further accelerated the daily displacement of the population. The subway system, the Métropolitain, has not yet been carried beyond the fortifications because of the opposition of small tradesfolk anxious not to lose their clientele. But public interest sooner or later will carry the system beyond its present limits into the suburbs. The necessary connections are now maintained by numerous tram lines and to a greater degree by the suburban railway system. It is sufficient to witness the arrival of the morning trains to appreciate the enormous stream of people that the suburbs each day turn into the city.

Even before the war the fortifications of Paris had been regarded as an anachronism. Since 1870 the defensive line had been carried well beyond the old forts so that the new "entrenched camp" was not less than 133 kilometers in circumference. The war showed still more clearly the uselessness of a continuous fortified enceinte. Demolition commenced in 1919. Parts of the old ramparts only will be kept as

memorials: in place of the rest will be laid out parks and workingmen's quarters. The "Zone" will disappear, to the great regret of lovers of the picturesque. Soon nothing will separate the quarters incorporated in 1860 from "extra-mural" Paris. It is this whole that we must today consider as urban Paris.

Greater Paris

This agglomeration considerably surpasses the boundaries of the administrative district of the *département* of the Seine. It invades the contiguous *départements* of Seine-et-Oise and Seine-et-Marne. It is not, however, concentric with the old fortifications but forms antennae-like elongations along the railroads. For this greater Paris is being occupied more and more by Parisians having their occupations in the town itself, heads of industrial concerns and commercial houses, and especially clerks and other small business folk, glad when the day's work is finished to breathe a freer air and work in their little gardens, for the Frenchman has an hereditary love of the soil. Side by side with this element is the indigenous working population, market gardeners who nightly carry to the central markets the vegetables and flowers they raise from a soil that is never idle. Certainly this dispersion of the Parisian population into the neighboring country is not to be regretted: indeed one may wish to see it extended to include all the unfortunate beings still shut up today in close-crowded quarters.

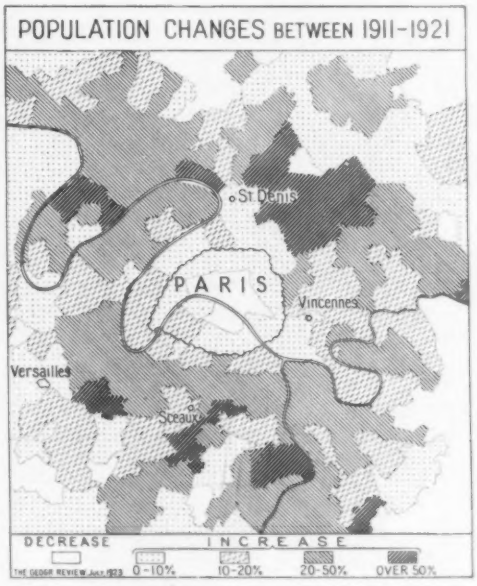

FIG. 16—Changes in the population density of Paris and its immediate vicinity (compare the map Fig. 17) in the decade 1911 to 1921. Scale approximately 1:650,000.

The last census permitted us to evaluate more precisely the number of people now living in the suburbs of Paris. The *département* of the Seine (population of Paris excluded) had 1,266,000 inhabitants in 1911. In 1921 it had, in spite of the enormous losses sustained by the war, 1,505,000. With Paris it counts 4,411,916 souls. But this greater Paris, as we have said, also includes parts of neighboring *départements*, and there also increase has been considerable. The gain in the *département* of Seine-et-Oise between 1911 and 1921 exceeds 104,000 and is exclusively due to communes forming part of the Parisian agglomeration. In giving the population of greater Paris as 4,500,000 one certainly does not err on the side of excess.

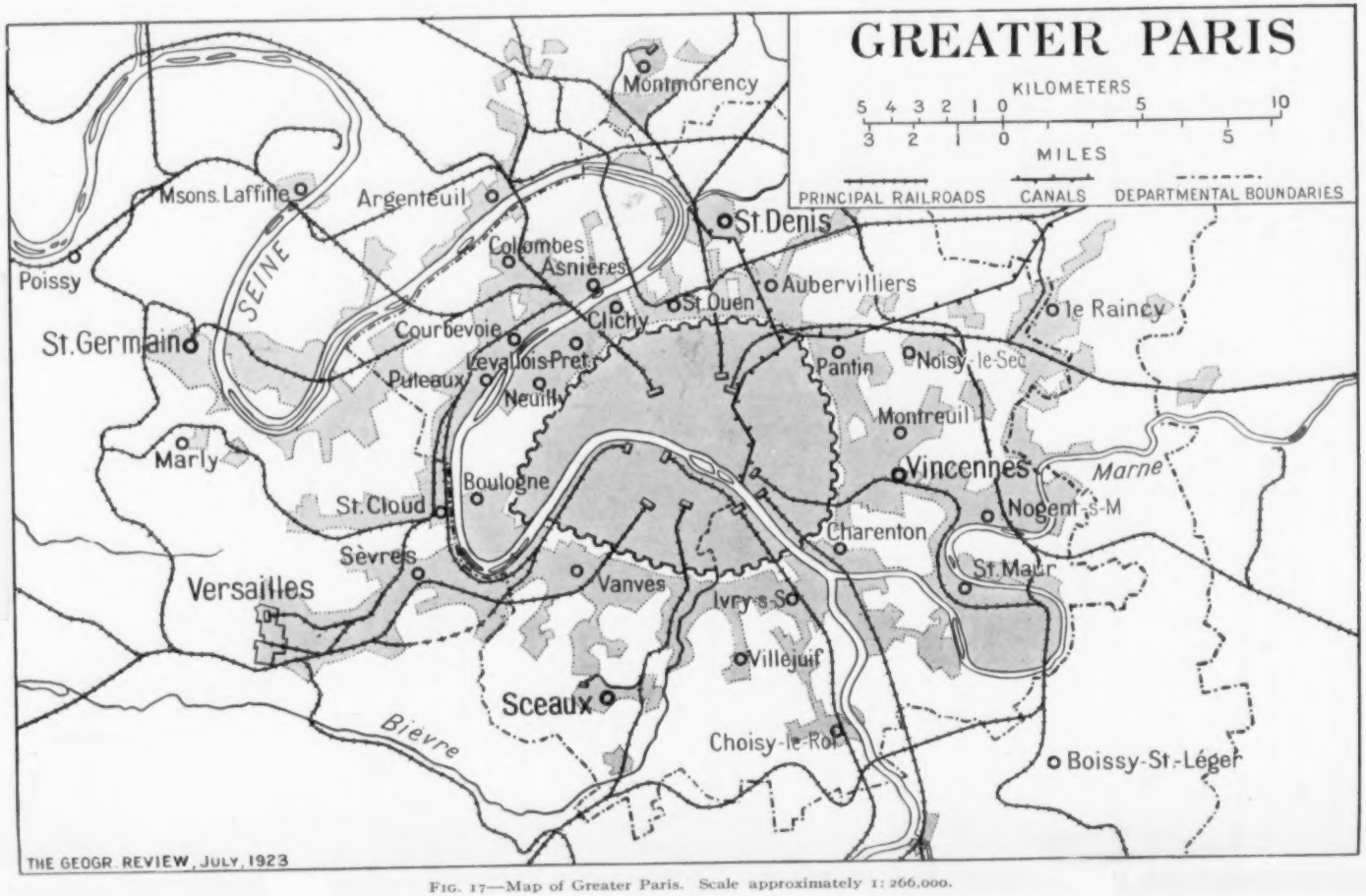

FIG. 17—Map of Greater Paris. Scale approximately 1: 266,000.

Figure 91.

Suburban Paris is a prolongation of the quarters of the city itself. As Paris for the last century has grown chiefly in a westerly direction, so it is to the west that we find the most densely peopled suburbs. On this side the communes of Neuilly (51,590), Levallois-Perret (73,639), Clichy (50,165), and, outside the *département* of the Seine, Puteaux (33,503), Courbevoie (46,053), Asnières (49,607), Bois-Colombes (19,888), Colombes (32,271) form, with Boulogne-sur-Seine (68,008), a group of more than 400,000 souls. But while Neuilly, bordering the beautiful grounds of the Bois de Boulogne, is the continuation of the fine residential section about the Arc de Triomphe, Levallois-Perret and Clichy make transition with the industrial suburb of the north which is a prolongation beyond the fortifications of the industrial quarter of La Chapelle. In this area, which has surrounded with factories the old church of St. Denis, lives a working-class population of over 175,000 souls. It is here that coal from the fields of the Nord is most easily brought by rail or water. This industrial zone includes Aubervilliers (40,832), St. Ouen (50,848), St. Denis (76,358), and the bordering communes. It is growing eastward by Pantin (38,975) towards Noisy-le-Sec (16,306); but it has respected the heights, once entirely wooded, which here overlook the valley of the Marne.

At the foot of the hills of Montfermeil is a considerable colony of small business people whom the railway puts in ready communication with the quarters in which are their shops and offices (altogether over 70,000 people). Prolongation towards the east of the elevated ground of Ménilmontant and Belleville has acted as an obstacle towards the outward pressure of population. This section is still only occupied on the immediate outskirts of the great city, but farther to the south nuclei of dense population reappear round the old chateau of Vincennes and beyond its woods laid out in walks and drives which overlook the confluence of the Seine and Marne. Here there are about 300,000 people.

The quarters of Paris on the left bank of the river have not furnished their suburbs with such large contingents. An almost continuous zone of industrial communes crowds over 200,000 souls about the old fortifications; but beyond there are empty spaces. The plateau lying between the Seine and the Bièvre is still largely given over to cultivation. In these two valleys served by railways the Parisian population has advanced, round the old villages of Sceaux and Bourg-la-Reine. But the movement is spreading and has reached the upper valleys of the Bièvre and the Yvette where the elegance of the summer homes is in harmony with the beauty of the site. Similarly country houses and *châteaux* continue along the pleasant hill slopes overlooking the left bank of the Seine from Meudon to St. Cloud and up to St. Germain. By the ravine of Sèvres, without leaving a gap in the populated zone, one reaches Versailles, whose tranquil charm has drawn thither many a Parisian. Connected with Paris by three railway lines, Versailles with its 65,000 population is today included within suburban Paris.

FIG. 17—Map of Greater Paris. Scale approximately 1:266,000.

THE GEOGR REVIEW, JULY, 1923

In many parts the suburbs have preserved their look of the country. If great establishments have been constructed on the parts which lie nearest the city, elsewhere small one-family houses separated from their neighbors by their little gardens are characteristic. Only the houses of the old villages are grouped together and with their narrow irregular streets break up the monotony of the broad roads and new buildings. Between past and present a junction has not yet been achieved. The change has been too rapid, and the old population of small farmers and market gardeners continues to live as before without mingling with the new comers.

Paris itself keeps in some of its quarters a scarcely changed air of the past. As in the old Paris of the Middle Ages, where the guilds of craftsmen were grouped by streets, the present-day population is not distributed by hazard but according to occupations and habitude. The vicinity of the Place de la Bastille has always been the domain of cabinetmakers. In the old *hôtels* of the Marais, which were in the eighteenth century a center of fashionable life, are installed today the shops of workers in bronze and copper. The valley of the Bièvre is the quarter of the leather dressers and tanners, but the polluted stream has now been converted into a sewer. In the center of the city in the neighborhood of the Bourse are the banks and large commercial houses which directly or through agencies handle the affairs of the entire nation, for today there is no great French industrial concern which does not have representatives and offices in the city. It is also the quarter of that Parisian art "*par excellence*," the creating of fashions, which supports thousands of women. The left bank of the river has its great publishing houses. This is the domain of the savants and artists and also, but further to the west, of the diplomatic corps. They are housed between the Senate and the Chamber of Deputies in the old mansions still surrounded with shady gardens which were in the eighteenth century the Paris of aristocracy and wealth before it migrated to the new quarters about the Arc de Triomphe and the Champs-Elysées. Such is workaday Paris, scarcely known to the tourist and very different from the noisy Paris of the boulevards, the theaters, and pleasure places.

Conclusion

Four and a half million people is one-tenth of the population of France. This disproportion between Paris and the other great towns of France has been a subject of anxious concern, and measures have been proposed to counteract what has been considered an excessive centralization. In reality the growth of Paris is largely due to general causes. Everywhere modern life with the rapid growth of communication which diminishes distance favors the movement towards large towns. These in France, as elsewhere, have been aggrandized at the expense of smaller towns; and they have become more and more the centers of the great French regions. Paris in particular has benefited by the advantages of its position. It is probable

that these general causes have not yet ceased to operate. It may be that current economic difficulties will slacken the movement, it may be that new industries will find more advantages at a greater distance from the immediate suburbs; but according to all appearances Paris will continue to grow, especially on the outskirts and especially when the barrier of the fortifications has disappeared.

But other causes have assured Paris her preëminence. Chief of all, as we have seen, is her function of capital. And this preëminence has incontestable advantages. Paris, the center of French life and the focus, one may say, of French thought, has largely contributed to the diffusion of that body of sentiment and ideas which is the soul of a nation. It is the idiom of the bourgeoisie of Paris which has superposed itself over other dialects and has become the common language of France, that which has been diffused and fixed by the great writers. It is the French administration whose head is in Paris which has similarly penetrated all the French provinces. This centralization, initiated and pursued by the Capetian kings, perfected by the Revolution and the Empire, should not be too harshly criticized today: it has made the unity of France, the safeguard of the country in her hours of peril.

THE FRANCO-SWISS FREE ZONES

By Charles Biermann

Universities of Lausanne and Neuchâtel

Switzerland is well marked off by nature from her encircling neighbors. Were her political boundaries nonexistent she would still be a country apart. The Jura, which encompasses the northwest, and the Alps, which occupy the south, are high enough for the winter snows to render communications difficult. The slopes are steep enough to compel the roads to seek the few natural passageways; the climate is so inclement that extensive areas are completely closed to habitation or are open to temporary utilization only. The empty spaces of high mountains between Switzerland and her neighbors are the best frontiers because they prohibit contact, whereas political frontiers so often provoke it.

Far apart in the northeast, where the Rhine furnishes only a poor frontier, the Jura and Alps draw together the southwest. The Jura, indeed, can be considered in effect as a branch of the Alps, uniting with it in the Échaillon, on the left bank of the Isère below Grenoble. Between the Jura and the Fore-Alps is a difference of structure only: the former is less intensely folded, the folds being the well-known type of simple undulations.

The Neutral Zone of Savoy

The angle of contact between the Jura and the Alps is the region of Savoy. Savoy is geographically Swiss if not so politically. In 1860 it was detached from the kingdom of Sardinia and united to France. Savoy, however, has also enjoyed a certain affiliation with Switzerland. The Congress of Vienna (1815) extended the guarantee of political neutrality not only over Switzerland but also over a large part of Savoy, including the old provinces of Chablais, Faucigny, and Genevois. Switzerland was authorized to occupy this neutral zone in time of war. Up to the present she has not found it necessary to avail herself of this right, and it is improbable that such an exigency will arise in the future.

The Lake of Geneva as a Boundary

A large body of water, the Lake of Geneva, lies between Savoy and Switzerland. Far from being a natural dividing line it is a bond of union between the peoples of the two shores. The lake has served as a political boundary only since the sixteenth century, and up to the present it has not functioned as an economic boundary. Relations between Savoy and Switzerland are close. Steamboats and sailboats traffic between French and Swiss ports. The Swiss shore, the richer and more populous, offers a market for

the vegetables, fruits, and other agricultural and horticultural products of Savoy and the more productive fisheries of that side of the lake. Large lateen-sailed boats carry building stone from Meillerie in Savoy for the towns of Vaud, and from this same source comes the material for the sup-

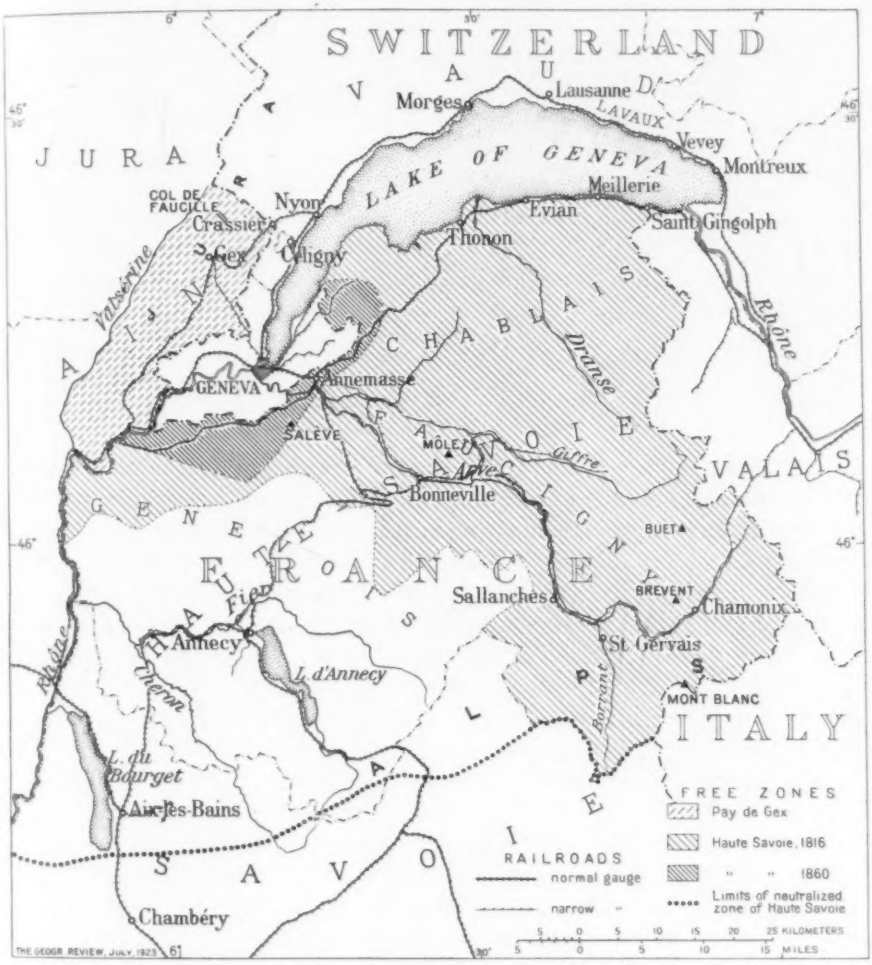

FIG. 1—Map showing the customs Free Zones of Gex and Upper Savoy and the neutralized zone of Upper Savoy.

porting walls of the terraced vineyards of Lavaux. Savoy also sends the necessary seasonal labor for the vineyards, while in the Swiss towns bordering the lake are important colonies of Savoyards, generally of the laboring class—day laborers, domestic servants, small tradespeople. Between these emigrants and the country of their origin there is constant intercourse.

The village of St. Gingolph on the southern shore of the lake is divided by the torrent of the Morge. On one side is Savoy, on the other the canton

of Valais. Although the two halves of the village belong to two different states, they have long since formed a single commune and still constitute a single parish (Roman Catholic) whose church is situated on the Savoyard side. The property of the bourgeoisie is still undivided, lying indifferently in either territory. Assemblies and festivals and other manifestations of public life are held in common. Traffic passes to and fro uninterruptedly by the bridges over the stream, and the inhabitants of the Swiss side cross it on their last journey—to the common cemetery.

On the other shore of the lake somewhat similar conditions are seen in the village of Crassier at the foot of the Jura. A stream traverses it separating the village of the canton of Vaud from that of the Pays de Gex, which has kept the old form of the name, Crassy. Difference of religion—Protestant on the one side, Roman Catholic on the other—accounts for the fact that Crassy does not enjoy communal autonomy (it is dependent on the commune of Vésenex), for which reason the relations between the inhabitants of the two parts of the village are less close than in the case of St. Gingolph.

The Situation of the City of Geneva

Until a century ago Geneva was in much the same situation. This old city, the natural capital of Genevois, became separated from the rest of the province in the struggle for independence against its bishop and against the counts and dukes of Savoy. At the end of the eighteenth century it possessed only an insignificant territory comprising the town and thirteen scattered rural communes, enclaves in Savoyard territory. At the gates of the town on the other side of the Arve lay Savoy. Savoy likewise extended along the right bank of the Rhone from Petit-Saconnex on the outskirts of Geneva, at least until 1601 when the Pays de Gex was ceded by the duke to the king of France. When Savoy became united to France for the first time, in 1792, Geneva was only a little enclave in French territory and six years later lost its independence. Restored in 1814 to its ancient freedom the territory of the city was shortly increased by the addition of six French and sixteen Savoyard communes with the object of assuring continuity of the Genevan territory with the rest of Switzerland. Even with this enlargement the canton of Geneva, with its area of 277 square kilometers, remains the smallest Swiss canton next to Zug. Furthermore, it only touches Swiss territory on about five kilometers, the enclave of Céligny in the canton of Vaud not included, while the French frontier (Pays de Gex and Savoy) extends over fifty kilometers. The canton of Geneva is too small to be sufficient in itself, and its sustenance zone is in France rather than Switzerland.

In fact, throughout the nineteenth century as in preceding centuries Geneva has drawn its food supply from the neighboring regions of France. It has been supplied by the market gardeners and farmers of Savoy and of the Pays de Gex, who bring thither their produce by cart, while other foodstuffs from greater distances come in by rail. The line from Eaux-Vives to

FIG. 2

FIG. 3

FIG. 2—Geneva seen from the lake: the roadstead; to the left, the cathedral of St. Pierre; in the middle ground, territory of the canton of Geneva; in the background, the mountain girdle (to the right the Crédo fronting the Montagne de Vuache) pierced by the gorge of the Rhone.

FIG. 3—Geneva and Le Salève, telephotographic view. Petit Salève to the left, Grand Salève to the right. In the cut between the two runs the rack and pinion railway from Veyrier to Monnetier. The calcareous walls of Salève furnish a training ground for alpinists.

Annemasse, by which Geneva is connected with the lines of Bellegarde, Thonon, Annecy, and Chamonix, and an important narrow-gauge system more than 100 kilometers in length unite the town not only with the farthest points of the Genevan country but with places beyond its limits. Con-

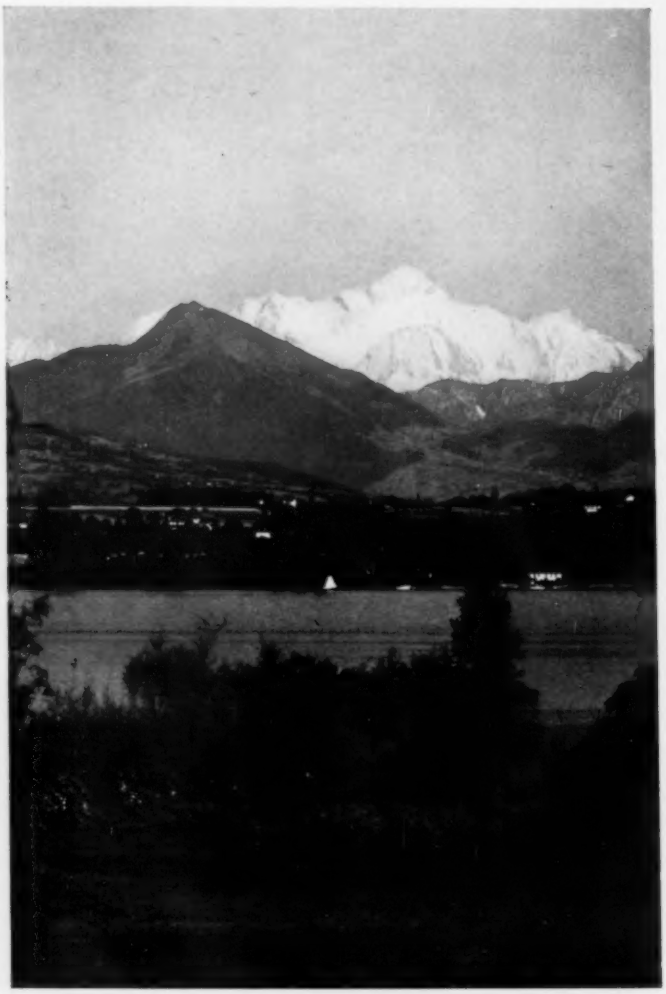

FIG. 4—Mont Blanc seen from Ariana (Geneva), telephotographic view. The lake, the mollassic hills, and the flysch Prealps (Voirons) covered with cultivation, forests, and pastures are dominated by the rocks and snows of the great mountain.

versely the French regions have sought products of Genevan industry. Geneva is the commercial metropolis of all the surrounding country without regard to nationality. No other town comes anywhere near it in size. It is the center of attraction for the rural population. In 1910 it had a colony of some 28,000 French, nearly all from Savoy and the Pays de Gex.

On the other hand, as the city grows, Genevan influence spreads. The Genevans have acquired considerable interests in Savoy: in lands, farms, factories, hotels, railroads. They have bought country estates and hunting preserves; they frequent the Savoyard inns and hostelries famous for their

FIG. 5—Lateen-sailed boat loaded with stone from Meillerie entering the port of Geneva.

good cheer, and thither they take their week-end excursions to field and mountain.

The canton of Geneva lies entirely on the plateau; a vast amphitheater surrounded by mountains territorially French. The Salève stands right on the frontier and, though it is not very high (about 1380 meters), offers from its summit a remarkable panorama of the town and its surroundings. It has

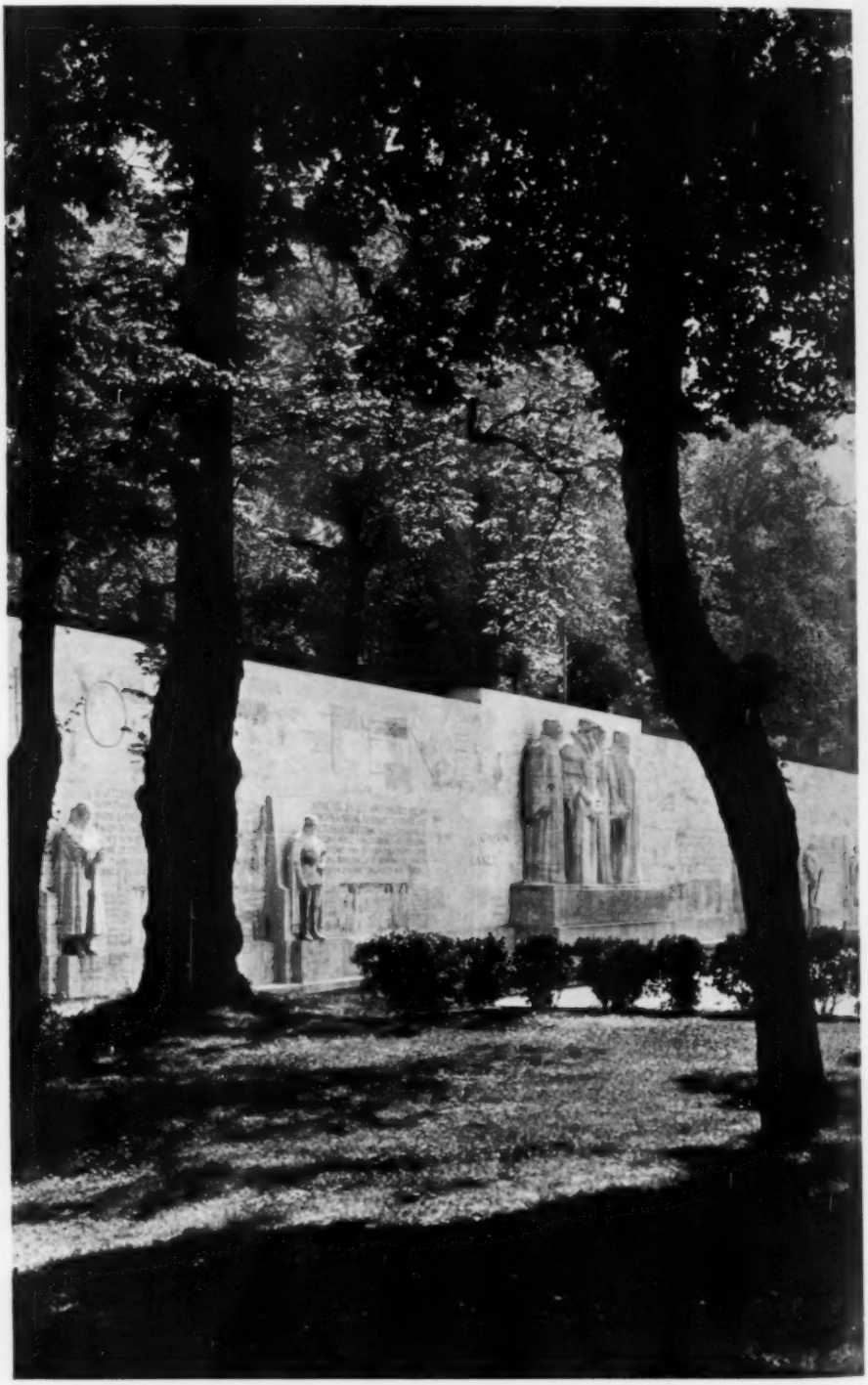

FIG. 6—The "Wall of the Reformers," a monument recently erected on a site in front of the old wall of Geneva. Isolated, from the religious point of view, by wholly Catholic regions (Savoy and Gex), Geneva has owed its dominance to its great reformers, Calvin, Farel, Beza, Knox.

been the training ground of most of the Genevan alpinists. On its northwestern side precipitous rock faces offer practice enough for mastering the granite needles of Mont Blanc. Mont Blanc too may be fairly claimed as a Genevan mountain. Was it not a Genevan, De Saussure, who made the first scientific studies and one of the first ascents of the mountain?[1]

Here alpinism had its rise, and here have been seen the beginnings of its transformation. It was a Genevan, Durafour, who made the first landing from an airplane on the Dôme du Goûter.

The Arve, which has its source in the glaciers of Mount Blanc, opens a magnificent route from Geneva into the Alps. But unfortunately it is a cul-de-sac. To provide an exit it would be necessary to tunnel under Mont Blanc. The Genevans have contemplated this solution, but it is blocked by the breadth (30 kilometers) and the height of the mountain (3800 meters above the valley of Chamonix). Furthermore, to make the line useful to other places it would be necessary to complete it by a line from Faucille under the parallel chains of the Jura. While these grandiose projects are awaiting development, the Arve remains an easy way of penetration into Savoy.

The Free Trade Zones

The geographical relationships between these several regions, the Pays de Gex, Geneva and its lake, and Upper Savoy have been frequently recognized in political history. The treaty of St. Julien (July 31, 1603) established the principle of freedom of trade between Geneva and the Duchy of Savoy, the Genevans being exempt from all taxes, tolls and customs duties. France recognized the same right of exemption for Genevans in relation to the Pays de Gex (May 25, 1602). At the Restoration Geneva demanded revival of these rights, which naturally had been suppressed during the incorporation with France. The free zone of Gex was re-established (by the Treaty of Paris, November 20, 1815), the line of French customs posts being moved back to the west of the Jura. The Treaty of Turin (March 16, 1816) established a similar free zone on the left bank of the Rhone, the "petite zone sarde" with a width of four or five kilometers. In addition it allowed freedom of passage for all necessary provisions for the town and canton of Geneva. In 1860 Savoy was ceded to France. Switzerland protested against the treaty of annexation in respect of the neutralized provinces of Chablais, Faucigny, and Genevois. A plebiscite held to ascertain the wishes of the population showed a considerable number of adherents to Switzerland, but the popular vote was for France. Under the slogan of "Oui et zone," the result was incorporation in France with the creation of a new free zone, the "grande zone de Savoie," or the "zone of annexation," including Chablais, Faucigny, and a small part of Genevois beyond which was established the French customs barrier.

It was under this regimen of free zones that Geneva, the Pays de Gex,

[1] See the biography of De Saussure by Douglas Freshfield with the collaboration of H. F. Montagnier, reviewed in the *Geogr. Rev.*, Vol. 12, 1922, pp. 519–520.

and Upper Savoy continued until 1914, the situation changing little in a century. On the Swiss side incorporation in that country has made Geneva a Swiss region with closely knit relations in intellectual, economic, and political matters.

On the French side sixty years of common life with France have effaced the particularism of the Savoyard. The common sufferings and losses of the world war—Savoyards furnished the major part of the heroic battalions of the *chasseurs alpins* (the "blue devils")—have cemented the new province to France. Savoy has taken on an extensive industrial development and looks for protection against Swiss competition.

During the war a police cordon was drawn round the political frontier, which considerably impeded intercourse between France and Switzerland. Prohibition of export of foodstuffs was made on both sides, and Geneva had to find its requirements in the neighboring Swiss cantons, more particularly in the canton of Vaud.

In consequence of these wartime developments and in pursuance of the general French policy towards administrative unification France on the conclusion of peace suppressed the "grande zone"—to the satisfaction of the population concerned—and inserted in Article 435 of the Treaty of Versailles a denunciation in principle of the "petites zones" and the neutral zone, the abrogation of which was accepted by Switzerland with reservations (see the annex to part XV of the Treaty). The convention of August 7, 1921, between France and Switzerland, upon which the verdict of the Swiss people is forthcoming, carries the line of customs ports to the political frontier and thus suppresses the free zones.[1] To ease adjustment to new conditions it is provided that for a period of ten years the inhabitants of the Swiss cantons of Geneva, Vaud, and Valais bordering Lake Geneva shall enjoy a part of the commercial facilities with the old zones, including the great zone of 1860. The special situation of the canton of Geneva with the district of Nyon (Vaud) bordering the Pays de Gex and the commune of St. Gingolph (Valais) is also recognized, special advantages of transportation and supply being accorded for an indefinite period.

The new state of things, whether with or without the privileges of the convention of August 7, 1921, shows again the influence of railroads and other means of rapid communication on the expansion of economic and commercial relations from the narrow limits of local circumstance to national and international scope. It also gives an interesting illustration of the evolution of the idea of the frontier—at first a band of country, or zone, then progressively narrowing until it becomes at last no more than a line.

[1] Since the above was set up in type the cantonal voting has taken place. By a strong majority vote the proposed customs agreement has been rejected, and other negotiations will be necessary (see *Econ. Rev.*, London, March 16, 1923, p. 231, and April 20, p. 338).—EDIT. NOTE.

THE NEW RUMANIAN STATE

REGIONS AND RESOURCES

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Rumania is one of the most vigorous of the newer states of post-war Europe. Before the war she had shown very considerable progress based in large measure on the rapidly growing importance of oil as fuel, of which commodity she possessed notable resources. Since the war the new boundaries have further added to her status (Fig. 1). Except on the south, where the Danube forms the confines, she has advanced in all directions. Her area has been more than doubled (113,600 square miles), and from an awkwardly disposed territory she has become one of the most compact of states.[1] A consideration of the present position of Rumania may be best begun with an account of the natural regions comprised within her new boundaries.

The Natural Regions

A general idea of the natural regions of Rumania which are shown in the map (Fig. 2) may be gained by traveling through the country from the west to the southeast. In such a journey one first passes through a transition region comprising a narrow zone of fertile river plains adjoining Hungary. This is better represented in the south, in the Banat, where intensive farming is practiced. Then a region of high broken contour is circumvented, the Bihar block, along whose borders one may see mining towns, although the greater part of the population is still working on the land. Next a part of the Transylvanian basin is crossed—undulating country composed of a series of fertile basins surrounded by wooded hills. From Transylvania one runs into the high mountains, the Carpathians, in places reminiscent of the Alps with bare rugged peaks and unsurmountable slopes but elsewhere, and especially in the central portion of the arc, recalling rather the Juras with wooded slopes and smooth grass-clad summits. Down the other side of the mountains the region of foothills is entered. Here in a smiling landscape where numerous valleys are flanked by low wooded hills one may see ancient and modern Rumania living side by side. Ancient Rumania is typified by the illiterate peasant living in his little wooden house so brightly painted, working his own field, in his own way, carrying on the age-old traditions. Modern Rumania is typified by the oil wells or by the aerial railway that brings down timber from the hills to the paper mills. From the foothills the road runs on to the plains of the Lower Danube—endless flat land for the most part treeless. Wide fields where crops are growing for export flank the roads. On the plain lie cities which serve as collecting and

[1] Emmanuel de Martonne: La nouvelle Roumanie, *Ann. de Géogr.*, Vol. 30, 1921, pp. 1–31.

distributing centers for the region. Passing the towns one goes on again over the never-ending steppe, which becomes more parched as one journeys eastward. The Danube is a welcome change, the neighboring marshes and the many broad branches of the river affording refreshment after the dusty plain. In the southern part of the Dobruja, which succeeds the plain, the land becomes more accidented without becoming more interesting. A bare limestone plateau crossed by wide dry valleys, as parched as the steppe,

FIG. 1—Map showing the territorial growth of Rumania from the recognition of independence by the Congress of Berlin, 1878, to the establishment of the present boundaries by the treaties of St. Germain with Austria, (1919), Neuilly with Bulgaria (1919), Trianon with Hungary (1920), and the declaration of the Great Powers, London, 1920, recognizing Rumania's claim on Bessarabia. (On earlier political limits see the map "Der rumänische Volksboden und die staatliche Entwicklung des Rumänentums," Pl. 35, *Petermanns Mitt.*, Vol. 61, 1915.) The stippled area represents the territory Rumania was required to cede by the Treaty of Bucharest, 1918 (see the map "Gebietsabtretungen Rumäniens an Österreich-Ungarn und Bulgarien," Pl. 8, *Petermanns Mitt.*, Vol. 64, 1918), which treaty, however, was never signed and was abrogated by the conclusion of the war. Scale of map 1: 7,000,000.

continues on to the coast. Here modern Rumania meets one again in the grain elevators and oil storage tanks of the growing port of Constantsa.

Let us examine each of these natural regions more closely.

THE MOUNTAINS OF THE CARPATHIAN SYSTEM[2]

The most striking feature of the build of Rumania is the great arc of high mountains which forms the backbone of the country. These moun-

[2] See Emmanuel de Martonne: Recherches sur l'évolution morphologique des Alpes de Transylvanie (Karpates méridionales), *Rev. de Géogr. Annuelle*, Vol. 1, 1906–07, pp. xi–xxi and 1–279; *idem:* The Carpathians: Physiographic Features Controlling Human Geography, *Geogr. Rev.*, Vol. 3, 1917, pp. 417–437.

tains of the Carpathian system go under different names in different parts. The section running from the Danube eastward, known as the Transylvanian Alps, merits its name by certain similarities with the Alps of Switzerland. Here may be found lofty jagged peaks, indented by glacial cirques, with lakes and cascades. The mountains as a whole, however, are neither so high nor so continuous a barrier. More characteristically they rise to rounded plateau-like summits penetrated by deep valleys, some of which

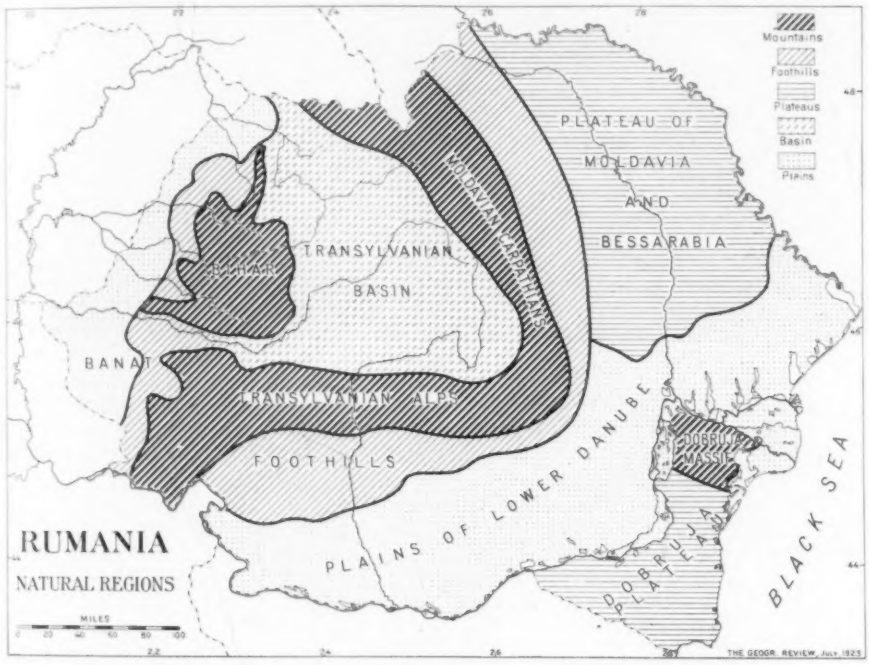

FIG. 2—Map showing the major natural regions of Rumania. The boundaries of the regions are drawn diagrammatically. Based on G. Murgoci and I. Popescu-Voiteshti: Carte géologique de la Roumanie et des contrées limitrophes, 1:2,500,000; G. Murgoci and I. Popa-Burca: Harta Fizica a României, 1:2,500,000 (accompanying Geografia României, New Ser., 3rd edit., Bucharest, 1921); E. de Martonne: Physiographic Map of the Carpathians, 1:2,500,000, *Geogr. Rev.*, Vol. 6, 1917, Pl. IV; and other sources. Scale of map 1:7,000,000.

cut a passage through the chain. East of the Predeal Pass the chain swings northward under the name of the Moldavian Carpathians. Scenery changes as well as direction. The ancient crystallines of the western section are replaced by weaker rocks. Here the Alpine type of scenery is entirely lacking. Altitudes are lower: the mountains present a maze of flat-topped summits with rounded wooded flanks. In the extreme north of the chain, the Mountains of Bukovina, the Alpine type again appears.

Such is the continuous arc of mountains which encircles the basin of Transylvania on its southern and eastern sides. The Bihar massif completes the mountain girdle of the basin on its western side. This block has been left standing while the surrounding land has subsided. A steep escarpment

FIG. 3

FIG. 4

FIGS. 3 and 4—Plateau-like summits in the Bucegi massif. Note the aerial railway for carrying down timber. The Bucegi massif, lying between the Dambovitsa and Prahova valleys, is a transition region between the Transylvanian Alps and the Moldavian Carpathians. It is especially interesting for the highly varied forms of relief exhibited. (Photographs by M. Harret, Sinaia.)

FIG. 5

FIG. 6

FIGS. 5 and 6—The Jura type of relief is seen in this part of the Bucegi massif. Figure 5 is in the upper valley of the Jalomitsa. The amphitheater formed by the headwaters of this stream is richly wooded to high altitudes. Figure 6 shows the head of a gorge. (Photographs by M. Harret, Sinaia.)

frowns over the valley of the Mures beyond which there stretch plateau-like summits deeply cut by streams and diversified by volcanic relief.[3]

The mountains of the Carpathian system have been the greatest boon to Rumania in the past, for here her persecuted people have fled in times of trouble. Numberless fertile valleys are still occupied by Rumanian farmers, descendants of these fugitives and representatives of the purest Rumanian type. Not only in the past but at the present the mountain zone is a great asset. The forests which clothe the flanks provide the material for one of the most promising of the growing industries, while the proximity of arid lands such as Egypt and large portions of the Mediterranean coastal regions

FIG. 7—Karst type of country in the Bucegi massif. (Photograph by M. Harret, Sinaia.)

make timber valuable as an article of commerce.[4] Further, the mountain streams provide the power to drive many mills. The age-old practice of transhumance, that is, the driving of flocks up to summer pasture and the return to winter in the lower land, still continues and provides a valuable link between the opposing flanks of the chain. Although the mountains themselves have no valuable mineral wealth except building stone, yet the same processes which formed the mountain chain are responsible for the mineral wealth which is found along their borders.

THE MOUNTAINS OF THE DOBRUJA

Distinct from the Carpathians in structure as well as position is the mountainous mass of the northern Dobruja.[5] It seems to be an isolated

[3] Emmanuel de Martonne: Le massif du Bihar (Roumaine), Étude morphologique, *Ann. de Géogr.*, Vol. 31, 1922, pp. 313–340.

[4] According to official Rumanian figures 20 per cent of the export of timber and timber products in 1913 went to Egypt and 12 per cent to Turkey.

[5] See the interesting block diagram by G. Vâlsan: Câmpia Română, *Bul. Soc. Regale Române de Geogr.*, Vol. 36, 1915, pp. 313–568; reference on p. 524.

overthrust of the same system as the mountains of the Crimea. The summits are wooded, and copper has been mined on the northern edge of the mountains; but their chief commercial importance at present is as a source of building stone.

Foothills of the Mountains of the Carpathian System

The Carpathian foothills of Rumania (including the foothills of the Banat), the extent of which is shown in Figure 2, are in many ways the most interesting part of the country. The hills, which rarely exceed 600 meters (2000 feet), are the remains of a dissected plateau. The valleys are from

Fig. 8—Sheep in the Carpathians at an altitude of 7500 feet. The Caraiman plateau, Bucegi massif. (Photograph by M. Harret, Sinaia.)

250 to 100 meters (800 to 300 feet) deep. They are exceedingly fertile and are well sheltered, separated but not isolated by the surrounding wooded heights. Conditions of safety, varied resources, comparative ease in gaining a living, with possibilities of intercommunication have supported a marked development of the characteristic Rumanian culture of the foothills. The costumes, embroidery, legends, and customs in this region bear witness to the individuality and wealth of this culture. The density of population is very great in some of the chief valleys of eastern Wallachia (Mutenia) and in the so-called sub-Carpathian depression which in places separates the mountains proper from the foothills.[6]

Such has been the rôle of the foothill region in the past; at the present time it still is one of the most important regions, for here is found Rumania's most remarkable asset, petroleum. The characteristic scenery of the foothills, the gay wooden houses of the Rumanian peasant, surrounded by fields

[6] Emmanuel de Martonne: La Valachie: Essai de monographie géographique, Paris, 1902.

of maize, with a flock of sheep on the near-by hillside and the cumbersome slow-moving oxcart, is suddenly replaced by an unsightly compound of temporary premises, with high pumping apparatus, chimneys, and rubbish heaps, while over all there lingers the smell of oil.

The Basin of Transylvania

The region of moderate relief second in importance is the basin of Transylvania. This area of relative depression, which lies however at a fairly high altitude, is itself broken up into a number of basins by low wooded hills. The hills are the remains of a much more accidented region; they have not only been worn down by erosion but also have been half submerged by the eroded material. There is similarity of structure but difference in the proportion of hill to plain as one journeys from north to south in Transylvania. Towards the north the hill gains on the plain, the stretches of flat land become smaller, and the general character of the scenery more undulating.

Transylvania is one of the most productive parts of Rumania and at the same time one of her greatest problems. The climate in summer is hot enough to ripen maize and grapes. The presence of timber, abundance of streams, sufficient rainfall, and fertile soil have always made of Transylvania an attractive region, and people have been drawn in from all the surrounding lands during all periods of history.[7] Mineral wealth has but added to the general diversity of the population. Rumanian hamlets or isolated farms, big German villages, straggling Hungarian towns come into sight one after another; every valley is occupied. To the Rumanian state Transylvania has brought agricultural products, salt, coal, iron and gold mines; but with them there is an ethnic problem of the greatest difficulty.[8]

The Plateaus of Moldavia and Bessarabia and the Southern Dobruja

The plateaus of Moldavia and Bessarabia resemble in structure the foothills region; but the climate is more arid, the loess-covered surface is greedy of water, and in consequence a very different landscape is presented. The wooded area is reduced as one journeys toward the east. The valleys also become broader and shallower. Agriculture is exceedingly profitable in the river plains, but the upland surface is far more monotonous and bare than in the foothill region.

The plateau of the southern Dobruja, still more arid, is essentially a steppe country. It is a limestone region characteristically deficient in surface streams, and, as in the country north of the Danube delta, the lack

[7] On the historical aspect see an interesting paper by James Berry: Transylvania and Its Relations to Ancient Dacia and Modern Rumania, *Geogr. Journ.*, Vol. 53, 1919, pp. 129–152. Note especially the map of boundary dikes (Fig. 14) and the photograph (Fig. 10) of one of the characteristic fortified churches of southern Transylvania.

[8] Cf. B. C. Wallis: The Rumanians in Hungary, *Geogr. Rev.*, Vol. 6, 1918, pp. 156–171.

FIG. 9

FIG. 10

FIG. 11

FIG. 9—Looking across the Danube valley (head of the delta) towards Ismail. (Photograph by Miss M. Pallis.)

FIG. 10—In the Danube delta. Most of the fishermen here are Lipovans, a religious sect emigrated from Russia. (Photograph by Miss M. Pallis.)

FIG. 11—Coast of the Black Sea north of Sulina, sea-drifted peat and sand. (Photograph by Miss M. Pallis.)

of water is rendered even more distressing by the covering of loess which is raised up as dust by tempestuous storms in the dry hot weather. A serious attempt is being made to develop agriculture in this region, for there is usually enough rain in spring to start the wheat, and the district round Constantsa is now producing sufficient for export.

The Plains

Mountain, hill, and plateau contribute to the wealth of Rumania; but always the plain stands first in importance, for on the plain are to be found the great wheat fields that make of Rumania one of the export granaries of Europe. In addition to the plain of the lower Danube, which continues into Bessarabia, is a narrow strip of plain on the western edge of Transylvania.

Plains of the Transylvanian Border

The plain on the border of Transylvania is the eastern fringe of the Alföld, the great plain of Hungary. The northern portion is comprised by the districts of Maramuresh and Crishana, the southern is a part of the Banat. Exceedingly fertile, well watered, tilled, and fertilized, it is one of the most productive regions of new Rumania. Here, however, is one of Rumania's grave problems in the large Magyar and other alien elements in the population.

Plains of the Lower Danube

The plains of the western border comprise but a small area compared with the great plain of the Lower Danube. This plain may be divided into eastern and western parts. The western part has sufficient rainfall to support a natural vegetation of rich grass, and here wheat and maize thrive excellently. As one travels towards the east the land becomes drier, and the natural vegetation is poor; but with careful cultivation wheat is profitably raised for the soil is exceedingly rich. In the great plains of Old Rumania one sees large-scale cultivation with machinery which, with the exceeding flatness of the land and the continental type of climate, recalls the Middle West of North America. Bucharest has a temperature regimen similar to that of Chicago, but one degree warmer, and an annual rainfall of 23 inches against 33 inches for the American city. The Danube delta has less than 15 inches of rainfall.[9]

These are the several natural regions comprised within the borders of the New Rumania. They bring together a variety of resources such as constitute the foundation for an exceedingly well-balanced state. We may now inquire as to the manner of their utilization.

[9] See the rainfall map by E. Otetelizanu and G. D. Elefteriu in *Bul. Soc. Regale Române de Geogr.*, Vol. 39, 1920, facing p. 222.

Utilization of National Resources

Land Tenure

We shall start with agriculture, for Rumania is essentially an agricultural country. First a word must be said as to the system of land tenure, as this has recently been modified with far-reaching results.[10]

Until 1864 Rumania had much the same system of land tenure as Russia; that is, a few landowners held the farming peasantry in a state of serfdom.

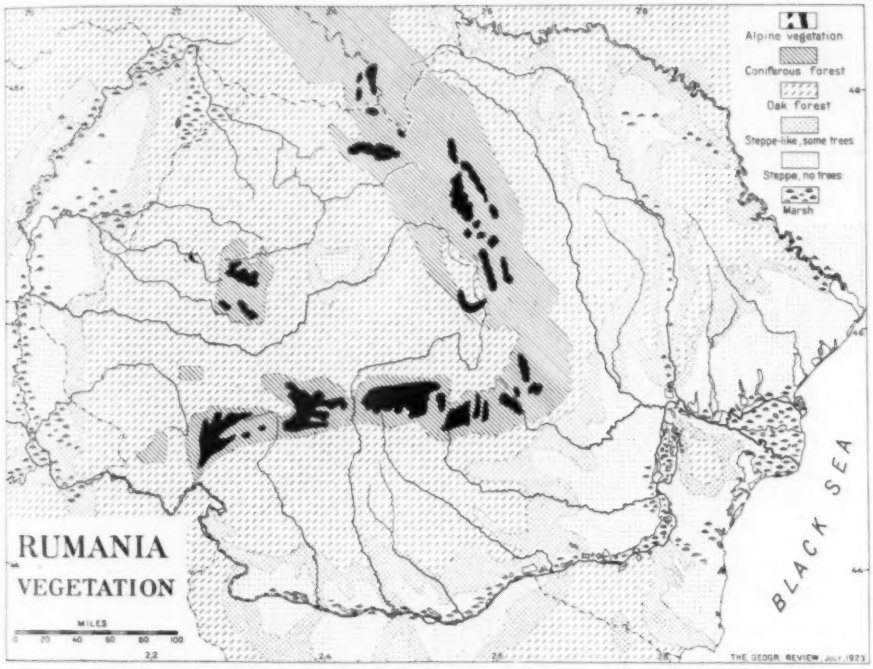

Fig. 12—Map showing the vegetation of Rumania. After G. Murgoci and I. Popa-Burca: Geografia României, New Ser., 3rd edit., Bucharest, 1921, map on p. 104. A larger-scale map (1:1,500,000) of the vegetation of the Old Kingdom after P. Enculescu is given in E. Nitz: Militärgeographische Beschreibung von Rumänien, Berlin, 1919. See also the maps of soils and woods in this volume. Scale 1:7,000,000.

At that date the peasants were freed; and the property of the monasteries, a matter of 4,000,000 acres, was expropriated and distributed among 400,000 peasants. In 1889, after a rising of the peasants, further relief was given by the division of the state lands, comprising about one third of Old Rumania. These lands were sold in lots to the peasants. In 1907, however, discontent provoked another revolt, and measures were again taken to reduce the size of the large estates for the benefit of the people. The peasants' holdings were still too small for their needs, and in 1912 and in 1914 there were disorders followed by further measures in the same

[10] G. Jonescu-Sisesti: Agrarian Reform and Agricultural Production in Roumania, "*Manchester Guardian Commercial*," *Reconstruction in Europe*, 1922–23, p. 514; *idem:* Land Reform in Roumania, *ibid.*, pp. 373–375.

direction. The status before the war may be summed up thus: large estates (that is estates exceeding 100 hectares, or 247 acres) formed 48 per cent of the cultivated area in Old Rumania, 45 per cent in Bessarabia, 34 per cent in Transylvania, 60 per cent in Bukovina. At the same time the average holding per family was 3.2 hectares in Old Rumania, 4.4 hectares in Bessarabia, 3.2 hectares in Transylvania, 1.4 hectares in Bukovina.[11] Acts have been passed to reduce the estates and Crown Dominions in Old Rumania still further, limiting them until they only occupy 8 per cent of the total arable land, and to expropriate the large landowners of Transylvania and Bessarabia.[12] Besides the division of large estates among peasant proprietors measures have been taken to give over large tracts of land to peasant associations for cultivation and common pasturage. The Ruma-

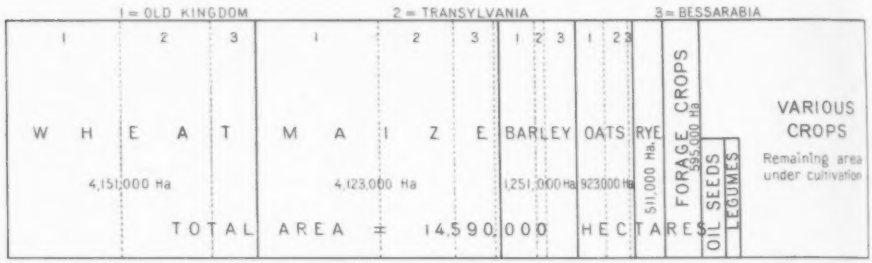

FIG. 13—Diagram showing the acreage of crops in Rumania. Based on a table in "La Roumanie économique," 1921, p. 12 (with correction of an error in the figure for maize in the Old Kingdom).

nian Minister of Agriculture, speaking in May, 1922, said that "five million hectares of arable land have passed from the hands of the large owners into those of nearly one and a half millions of heads of peasant families." He added that when the reform was carried through, "out of a total of 13 million hectares of arable land possessed by Greater Rumania, 12 million will have definitely passed into the hands of about 4 million peasants, in separate lots varying from 1 to 5 hectares according to the region and the density of the population. One million hectares only will remain in the hands of about 6000 owners, an average of from 100 to 200 hectares per head . . ."[13]

AGRICULTURE

Agriculture is still the main industry of the country, not only supporting the inhabitants but also furnishing the chief exports. Three-quarters of the inhabitants of Rumania are employed in agricultural pursuits, and the greater part of these are engaged in crop raising: 45 per cent of the land is arable. From Figure 13 it is evident that wheat and maize are the two

[11] La Roumanie économique, 1921, Office des Études et Enquêtes, Ministère de l'Industrie et du Commerce, Bucharest, 1921, p. 10.

[12] *Ibid.*, pp. 24–25.

[13] H. M. Conacher: Agrarian Reform in Eastern Europe, *Internatl. Rev. of Agric. Economics*, Vol. 1 (N. S.), 1923, Rome, pp. 3–18; reference on p. 15.

chief crops by a long way. The districts that contribute most are Old Rumania and Transylvania, with Bessarabia a good third. The contribution of Bukovina was in each case too small to plot effectively. The figures from which the diagram was constructed give only the area under each crop; the amount produced per acre varys a great deal according to the fertility of the land and the methods of cultivation. In Bessarabia, for example, the average yield of wheat is not more than 13 hectaliters to a hectare, while in Old Rumania the figure is from 15 to 18; and in parts of Transylvania, for example the Banat and the plains of Arad, the yield is higher still. The average for all Rumania is 15.7.

Wheat is grown largely for export. The staple food of the peasants is maize, which, however, also contributes substantially to the exports.

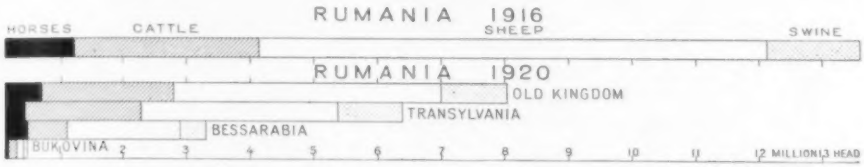

FIG. 14—Diagram showing distribution of live stock in the major political division of Rumania after the war (figures from *Correspondance économique*, Bucharest, July, 1922, pp. 5–6). Figures for the Old Kingdom before entry into the war are given for comparison (from La Roumanie économique, 1921).

Division of the large estates among the peasants probably means that more maize will be grown and consumed in the country and less wheat will be grown and exported. Further, a general decrease in yield is inevitable. Even if the peasants could co-operate to use machinery the peasant-proprietor system must make the raising of extensive crops for export difficult, especially while the level of education of the peasant is as low as at present. As a matter of fact the peasant has not yet reached the stage of wishing to use machinery for farm work. Oxen plow and drag his carts, and fertilizers beyond those furnished by the farm itself are unknown to him. The greater yield per acre of the Banat is due to the use of chemical fertilizers, and the large estates of the plains of Old Rumania have furnished proof of the wonderful utility of machinery in dealing with large areas on the plain and in combating the loss that is likely to occur from unfavorable weather. Thus it is to be hoped that in time the peasants may combine and bring their farming methods more up to date. Already some of the peasant co-operative societies have a system of lending certain agricultural machines.

The variability of returns in agriculture is a very serious question. Rumania is on the borderland between well-watered western Europe and the arid lands of southeastern Russia and the Near East. A slight variation in rainfall means serious loss; for example a slight reduction in the spring rains when the young plants are growing or a slight increase in summer when the grain is forming may ruin the crops. In the newer small holdings

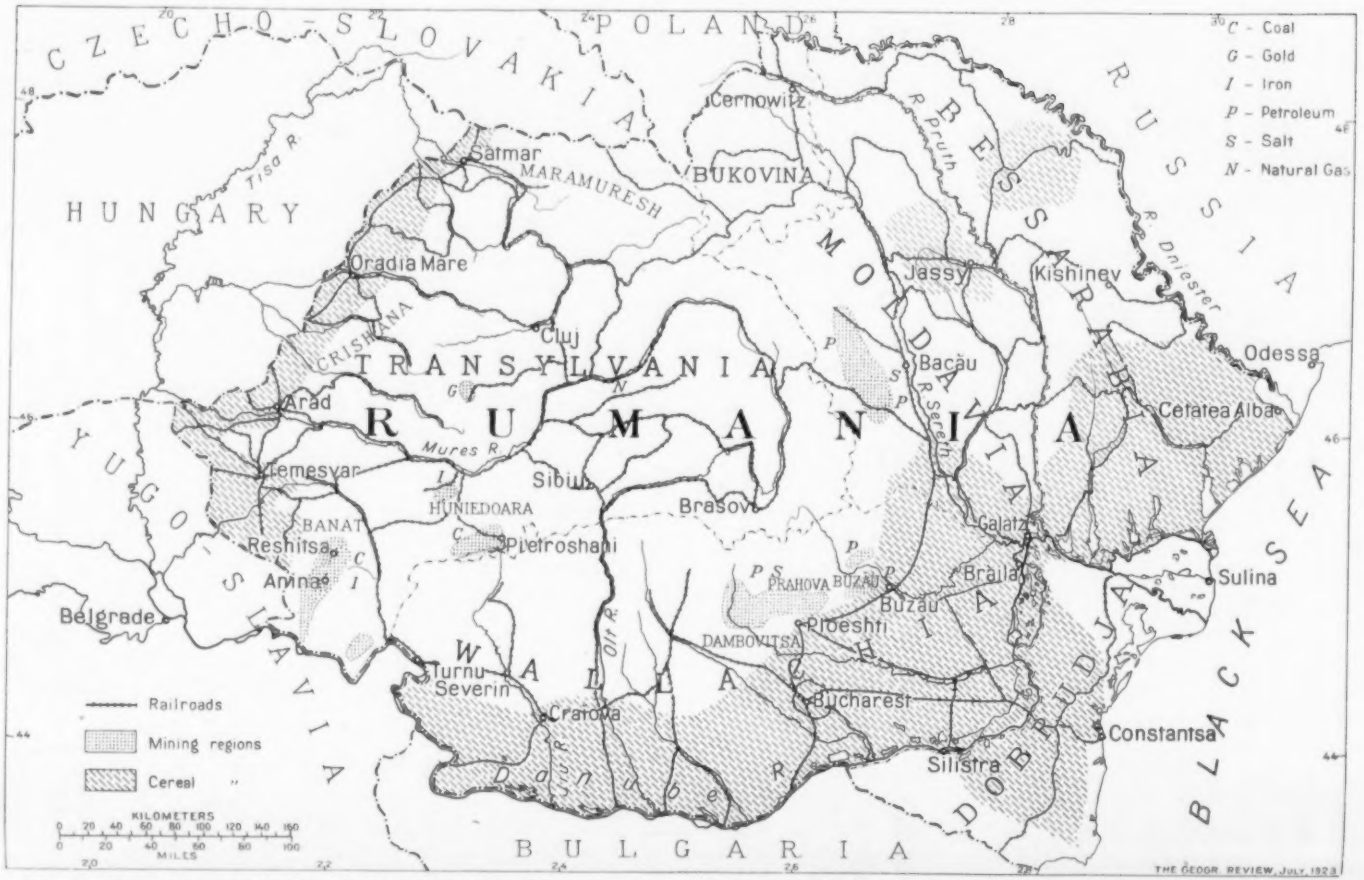

FIG. 15—Map of Rumania showing the chief towns (industrial centers, ports, and grain *entrepôts*), grain-producing areas and mining regions (following in part the map accompanying M. de Martonne's article cited in footnote 1), and railways. Scale approximately 1:5,000,000.

there is not the same possibility of tiding over a bad year as there was on the large estates. Again it looks as if co-operation were the only way out of the difficulty.

Animals, hides, skins, wool, and hair all figure in the list of exports; but compared with grain they are unimportant. For the people of the country, however, live stock is an essential part of the farm economy, especially oxen, which are the draft animals. The peasants do not eat much meat, and as a rule its production is for the neighboring towns. In the cattle industry, Transylvania leads, if the number of cattle is considered with regard to the number of inhabitants. In 1917 there were 440 cattle for every 1000 inhabitants. Nor did Transylvania suffer in the war in loss of cattle as did Old Rumania, who found herself crippled for want of draft animals when the war came to an end. Transylvania also has more sheep per head than have other parts of the country; she has 790 for every 1000 inhabitants. The relief of a large part of Transylvania makes shepherding a more profitable occupation than agriculture; while the plains of Old Rumania are agricultural land *par excellence*, although the relation between crop growing and the rearing of animals varies from time to time and from place to place. Bessarabia specializes in the breeding of horses, as is natural on the border of the steppes. The Banat and Bukovina raise quantities of pigs, largely in connection with the growing of maize. All the animal industries date from antiquity, but they received a stimulus from the general era of prosperity enjoyed before the war, for the growth of large towns made an increased supply of meat necessary. Figure 14 shows the actual number of animals in each division and also gives some indication of the loss of draft animals incurred by Old Rumania during the war.

In Old Rumania forests covered less than one-fifth of the land area. Wood, however, has played an important rôle in the domestic life. Absence of wood on the plains was undoubtedly one of the factors delaying settlement there,[14] just as the open prairies failed to attract the early settlers in Illinois.[15] In the new Rumania the proportion of forest is some five per cent greater, the forestal resources of Bukovina (= beechland) and Transylvania, where the forests occupy respectively 43 and 38 per cent of the surface, more than balancing the forestal poverty of Bessarabia.

A passing reference may also be made to the fisheries specially important in the Balta region, that is the 10 to 12 mile wide stretch of river channels, islands, and marshes of the Danube between the heights of Dobruja and the Baragan steppe.

Mineral Wealth

The mineral wealth of Rumania includes petroleum, coal, iron, natural gas, gold, salt, copper, iron, and manganese. Of these petroleum is by far the most important. Rumania's chief claim to present world importance

[14] E. de Martonne, article cited in footnote 1, p. 23.

[15] H. H. Barrows: Geography of the Middle Illinois Valley, *Ill. State Geol. Survey Bull. No. 15*, Urbana, 1910, p. 77.

Fig. 15.—Map of Rumania showing the chief towns (industrial centers, ports, and grain *entrepôts*), grain-producing areas and mining regions (following in part the map accompanying M. de Martonne's article cited in footnote 1), and railways. Scale approximately 1:8,000,000.

is based upon her oil production (see Fig. 16). Many other countries can produce cereals on a large scale, but to few young states is it given to be fourth in the world production of an important fuel (as Rumania was for several years before the war)—a fuel, moreover, whose total amount is strictly limited and for which the demand is enormous and increasing. The greatest amount in pre-war times came from the Prahova field, of which Ploeshti is the center. The returns for March, 1922, show that the Prahova field still produces over 80 per cent.[16] Along the foothills region there are other fields, but of less importance. Dambovitsa is the center of one to the west of Ploeshti, the Buzău field is to the east of the Prahova, while the Bacău field is in the Moldavian foothills further north. It is probable from the geological structure that there are large deposits as yet untouched.[17] The oil belt of Rumania is continuous with that of Galicia, and promising indications have been obtained in Bukovina, for instance.

Figure 16 is of further interest here as a comment on the effects of the war. Failure of the petroleum industry to recover its pre-war standing is explained in part by the fact that more than 1500 wells were put out of action before the Rumanian retreat. In addition to this deliberate destruction, the enemy before they departed inflicted great loss on the plant necessary to the oil industry. Reservoirs capable of holding 1,000,000 cubic meters were destroyed, about 1000 wells were burnt out, and refining and pumping plant to the value of 400,000,000 lei (in normal exchange 25.22 lei = £1 sterling) was destroyed. The difficulties of reconstruction in this industry are enormous. All Central Europe from which material and workmen could be drawn has been in the throes of terrible distress. In addition lack of rolling stock and insufficient means of transportation generally (the pipe line to Constantsa has been out of operation) have made it impossible to get that which has been produced to the coast for export. Not only has the amount for export been limited but the amount needed for home consumption has not been forthcoming. This is the more serious as up to now the railways and the manufactures (which are as yet in their infancy) have used oil as fuel. Now it is proposed to substitute coal for the railroads, while the natural gas that is being worked will probably supplement oil in the factories.

Natural gas is found in the basin of Transylvania in the basin of the upper Mures (Maros), east of Turda. It occurs at an average depth of 250 meters and at a pressure which allows the use of pipe lines, of which there are three. In November, 1922, there were already as many as 40 borings.

The calorific value of the natural gas that can be produced each year in Transylvania is greater than that of the coal produced in the whole of Rumania in a year. The cost of securing the gas is one tenth that of securing coal, and its transportation is easier. Engines made for coal fuel can be readily adapted to the use of gas. It seems probable, then, that

[16] *Correspondence Économique*, Fourth Year, No. 13, June, 1922, Bucharest, p. 24.
[17] L. Mrazec: Compte Rendu Congrès Internatl. du Petrole, 1907.

there may be a change in the manufacturing centers of the country. At any rate here is another powerful ally for industry in Rumania.

Old Rumania was lacking in the elements which most favor the development of manufactures, that is coal and iron; but the new boundaries include the coal fields and iron mines of Transylvania and the Banat. The coal fields with the lignite workings in the foothills of Old Rumania give about 4,000,000 tons of coal—not a great quantity but sufficient to reduce in considerable measure the costs of importation. Besides the useful if not extensive deposits of iron ore there are established metallurgical industries in Huniedoara (Transylvania) and Reshitsa-Anina (Banat). In the Bihar is an ancient gold-mining industry with deposits reputed to be the richest in Europe next to those of the Urals. The Transylvanian salt deposits

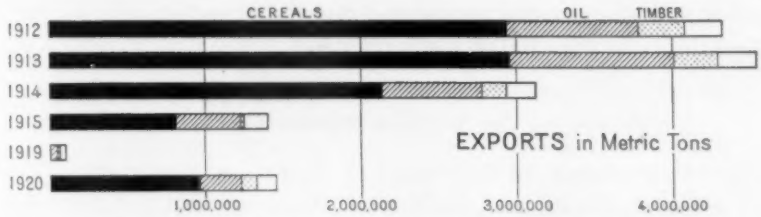

FIG. 16—Diagram showing the annual exports of Rumania by weight.

similar to those on the eastern side of the Carpathians double the already excellent resources of the Old Kingdom in this mineral. Mention may also be made of the large deposits of mica discovered in 1918 in the foothills of Wallachia.

COMMERCE

From the foregoing it is evident that Rumania is well equipped with the materials that go to build up commerce. The products of the natural regions are sufficiently varied to encourage domestic trade, while certain raw materials are produced in excess and can be exported in exchange for manufactured goods. Analysis of the commercial status of the new Rumania, however, is not easy. The Old Kingdom before the war showed a satisfactory development which we shall first examine.

The most striking feature of the Rumanian export trade is the preponderance of agricultural produce.[18] In 1913 grain formed two-thirds of the total value. During the period 1909–1914 Rumania ranked fifth among the wheat-exporting countries of the world and second in the exportation of maize. Oil is next in importance, at its period of maximum development accounting for one-sixth of the total value. The only other item on the list worth separate mention is lumber, amounting in 1913 to one-eighteenth of the total value.

[18] See Clive Day: The Pre-War Commerce and the Commercial Approaches of the Balkan Peninsula, *Geogr. Rev.*, Vol. 9, 1920, pp. 277–298. The last really normal commercial year for the Balkan countries and Rumania is 1911—i. e. before the Balkan Wars.

The most striking feature of the import trade is the preponderance of manufactured goods, which in 1913 composed five-sixths of the total value. A hopeful sign for the industrial future of the country is the prominence of metal goods and machinery, which together constituted over one-third of the total. Another important group is that of the textiles, in which cotton yarn and cloth are the outstanding items, the luxury products such as linen and silk being bought in relatively small quantities. There is only a small proportion of food luxuries—sugar, coffee, and tea—and an exceedingly small importation of raw materials. Rumania is still essentially a peasant state, and the peasant needs serviceable clothes and agricultural equipment but has neither taste nor money for foreign food or clothes. Petroleum exploitation explains a good deal of the importation under the classification of metal goods and machinery, which are also required by the mines and the growing industries; but the manufactures for the most part find their raw material in Rumania itself.

Effects of the War on Rumania's Commerce

Figure 16 also shows the beginnings of the post-war recovery. Although there has been a continued gain since 1919, direct and indirect results of the war still render conditions abnormal. War losses are still felt: above all, the loss of draft animals and agricultural equipment, the loss of rolling stock on the railroads, and destruction of the permanent way. As has already been pointed out, land distribution has had the immediate effect of lessening production. The state of exchange has reduced the purchasing power of the country; and, in addition, the acquisition of the new territories has created a currency problem "more easily imagined than described."[19] Old currents of trade have been disturbed by the erection of new frontiers. An instance is given by Professor de Martonne who describes a paradoxical situation in Transylvania, which is "too rich" in some of its resources. Closing of the Hungarian frontier and difficulty of transportation to Old Rumania have brought about such surplus of cattle that they are sold on the spot at very low prices.[20]

The export trade of Rumania has always been subject to fluctuations following the character of the harvest. In 1920 and 1921 Rumania, in common with other countries of eastern and southeastern Europe, suffered from drought; and export of wheat was forbidden by the government. Again, the reduction of petroleum exports is due not only to general conditions in the industry but to increased domestic demands. It is estimated that the addition of territory will call for a total domestic consumption of 70 per cent of production.

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[19] Alexander Adams: Report on Economic Conditions in Roumania, April, 1921, Dept. of Overseas Trade, London, 1921, p. 24.

[20] Emmanuel de Martonne: La Transylvanie, *Bull. Soc. de Géogr. de Lille*, Vol. 64, 1922, pp. 93–102; reference on p. 98.

Currents of Trade

Before the war about three-fifths of Rumania's imports came from Austria-Hungary and Germany and about a quarter from the other industrial countries of western Europe (Great Britain, France, Belgium, and Holland). Of the exports only one-eighth went to the former group; two-thirds went to the countries of the latter group, and of them Belgium took more than half, Antwerp acting as an entrepôt for further distribution. Germany and Austria are now far less favorably situated for trade with Rumania. Where Germany formerly held a privileged position she now faces the customs barriers of the new Slav states. Austria has lost her chief industrial districts to one of these states. In this connection note may be made of the importance of the commercial treaties recently concluded by Rumania with Czecho-Slovakia and Poland.

Professor Day in his study of Balkan commerce[21] pointed out that a surprising proportion of trade between Austria-Hungary and Germany and Rumania was carried on by rail (see the accompanying table).

Table I—Trade of Rumania, 1912

	With Germany			With Austria-Hungary		
	Rail	River	Sea	Rail	River	Sea
Exports	5%	5%	90%	87%	5%	8%
Imports	52%	2%	46%	92%	7%	1%

Chaotic conditions of land transport as well as political considerations are likely to cause a diminution in these former trade currents. On the contrary, trade by river and sea is likely to gain. In the Danube Rumania possesses an important commercial artery susceptible of greatly increased utilization. Trade on the Danube has suffered both from political discrimination and physical disabilities.[22] In the past it was hindered by the tariff imposed by Austria-Hungary to encourage the port of Trieste. Improvement of the waterway is needed particularly in the Iron Gates section, a matter in which Rumania is now still more interested because of the extension of her riparian territory. She will seek to divert exports from the Banat downstream from the former course upstream to Budapest.

In Old Rumania traffic on the Danube, which increased steadily downstream from Turnu Severin, was principally in grain. Sixty per cent of the grain was shipped from Sulina at the mouth of the channel regulated by the Danube Commission. Since 1920, however, the tendency has been to ship more grain from Briăla, which like Galatz is not only a shipping town but also a collecting center. Constantsa also shares in the grain trade and is the petroleum port with a special petroleum basin, storage tanks, and pipe lines that formerly crossed the Danube by the Cernavoda bridge. This

[21] See footnote 18.

[22] Cf. the note on "The Danube as a Waterway" elsewhere in this number of the *Review*.

famous bridge, destroyed during the war and reopened in 1922, also gives Constantsa rail connection with the trunk line running west through Bucharest and north through Buzĕu to Cernowitz. While the Danube ports are usually ice-bound during the winter, Constantsa has the advantage of being open throughout the entire year.

The new territories are better equipped with railroads than the old kingdom except in the case of Bessarabia, where particular difficulty has been experienced in grain shipment. The lines here were of different gauge and tended to converge on Odessa but normalization of guage and building of new lines is in progress. Nor has it been possible to take full advantage of the rivers, Pruth and Dniester, which like all the other Rumanian waterways are suffering from lack of equipment lost during the war.

With the rehabilitation of waterways and railroads Rumania's commerce cannot fail to develop. She occupies a geographical position highly favorable for international trade, lying contiguous to the crossroad between western Europe and the Near East and the Russian lands and the Mediterranean.

The Population

In considering the future of Rumania two aspects of the human element call for special mention here, the problem of education and that of the alien population.

While the new Rumania probably includes a somewhat greater proportion of urban population, the vast majority still remains rural. Out of 16 to 17 millions,[22] more than 14 millions are villagers; and of the town dwellers only about half are engaged in manufacturing and mining. When one reflects that the Rumanian peasants are poorly educated and in general ignorant of modern methods of farming and that they have in their hands the greatest asset of the country, the importance of their education is seen to be immense. Another problem in education is presented by the growth of the state in industry and commerce. The present exploitation of oil and other minerals is largely carried on by foreigners—an unsatisfactory condition for national progress. Promise of improvement in this direction, however, is given by the opportunities now offered by the universities (Bucharest, Jassy, Cluj, Cernowitz) and the technical institutes. The proposed budget shows that the Rumanian government is seriously occupied with the problem of national education.[24]

The physical complexity of this country at the meeting point of Balkans, Central Europe, and the Russian plains has had a bearing on the present state of ethnic complexity.[25] Surrounding the solid Rumanian block of the

[22] The *Bul. Soc. Reg. Române de Geogr.*, Vol. 39, 1920, p. 381, gives the population of Rumania as 16,262,000 distributed thus: Old Kingdom, 7,897,000; Bessarabia, 2,345,000; Bukovina, 812,000; Transylvania, 2,686,000; Crishana, 1,145,000; Maramuresh, 467,000; Banat, 910,000.

[24] Aristide Blank: The Public Finances of Rumania, "*Manchester Guardian Commercial*," *Reconstruction in Europe*, 1922–23, pp. 292–295.

[25] For a study of the ethnic composition of the new Rumania see Emmanuel de Martonne: Essai de carte ethnographique des pays Roumains, *Ann. de Géogr.*, Vol. 29, 1920, pp. 81–98, and also the article of the same author cited in footnote 1.

Old Kingdom is a belt of largely mixed population. Poles, Ruthenians, Little Russians, Tatars, Turks, Greeks, Bulgars, Serbs, Slovaks, Hungarians appear in succession and overlapping as one goes round the circle. The Hungarians known as Szeklers form a solid group in the heart of Transylvania, and Germans are widely distributed throughout the mixed zone; Jews are most numerous in the northern part of the country and in the towns. The alien element amounts to between 20 and 25 per cent of the population of the entire country. From this point of view Rumania has on her hands a more complex minorities problem than any other European state, and her treatment of the matter may be looked upon as a test case of the form of treaty devised for its solution.

THE POPULATION OF POLAND ACCORDING TO THE CENSUS OF 1921

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The new international boundary lines on the political map of Europe enclose territories for which there were not available proper statistics of population and industry. The parts of which such national units were composed had statistics of different dates taken under quite different conditions and methods. Among all the new political units the case of Poland offers the best illustration of these difficulties.

The first attempt at the reorganization of statistics on a national basis was made during the war by the author of this article in collaboration with a number of Polish scholars and was published as an atlas with descriptive text.[1] The area included was that of "historic" Poland, that is just before the Partition of 1772 when the Polish state occupied 753,000 square kilometers together with certain contiguous territories having a large Polish population.[2] The difficulties in the way of producing such a work may be comprehended if it is recalled that for twenty years there had been no census of the greater part of the country and in the whole of the country the statistics were deliberately altered by the three powers (Russia, Austria, and Germany) that participated in the division of Polish territory. The first and last Russian census was taken in 1897. In 1912 there were three different official figures for the population of Congress Poland—11,913,926; 12,782,347; 13,274,700. For the population of the six so-called Western governments of Russia, comprising the ancient Polish provinces of Lithuania and Ruthenia, there were in 1909 two official figures—22,633,807 and 24,189,000. In the case of some of the smaller units of administration (*powiats*) the official figures varied by as much as 20 per cent, as has been proved by Szulc.[3]

These preliminary remarks are sufficient to indicate the importance of the Polish census of September 30, 1921. It is the purpose of this article to point out some of its significant results. The area comprehended is that of the Polish states as constituted on September 30, 1921, together with the district of Wilno (Vilna)[4] and the parts of Prussian Silesia which were united

[1] Eugeniusz Romer: Geograficzno-statystyczny atlas Polski (Atlas de la Pologne, géographie et statistique) 32 sheets of maps with 32 sheets of accompanying text, in portfolio. Warsaw and Cracow, 1916. Reviewed by R. H. Lord in the *Geogr. Rev.*, Vol. 11, 1921, pp. 308–309.

[2] See the writer's article "Poland: The Land and the State," *Geogr. Rev.*, Vol. 4, 1917, pp. 6–25.

[3] Stefan Szulc: Appréciation des données statistiques relatives à l'état de la population de l'ancien R. de Pologne. Office Central de Statistique de la République Polonaise, Warsaw, 1902.

[4] It is desirable that the official Polish form "Wilno" should replace the now conventional "Vilna" which came into use during the nineteenth century as a result of Russian influence. Wilno was from the earliest times, even as a capital of ancient Lithuania inhabited by White Russian (Ruthenian) people known as Wilnia, whence the Lithuanian Wilniuja and the Latin Vilna. For centuries the Polish form has been Wilno. It appears thus in two cartographical works of capital importance for Polish toponymy: Joannes Jacobus Kanter: Regni Poloniae . . . Nova Mappa Geographica, 1770 and J. A. B. Zannoni Rizzi: Carte de la Pologne, 1772.

with Poland after this date,[5] the figures for which have been taken from the Polish census of December, 1919, and the German census of the same year respectively.

General Results of the Census of 1921

Table I gives the total population, population density, and number and percentage of Poles in the greater administrative units (*województwo*).

Table I—General Results of the Census of 1921

Administrative Division	Area Square Kilometers	Total Inhabitants	Inhabitants per Sq. Km.	Number of Poles	Percentage
1. City of Warsaw	121	931,176	—	673,320	72.3
2. Warsaw	29,310	2,112,108	72	1,895,186	89.7
3. Lódź	19,034	2,251,097	118	1,859,488	82.6
4. Kielce	25,736	2,534,214	98	2,312,374	91.2
5. Lublin	31,160	2,085,557	67	1,776,047	85.2
6. Bialystok	32,518	1,302,259	40	996,014	76.5
7. Wilno	14,105	499,499	35	343,335	68.8
8. Nowogródek	38,190	1,300,069	34	649,719	50.0
9. Polesie	41,463	876,665	21	190,700	21.8
10. Wolhynia	29,943	1,433,157	48	207,932	14.5
11. Poznań	26,558	1,974,057	75	1,628,522	82.5
12. Pomerania	16,374	939,495	57	754,907	80.4
13. Silesia (Katowice)	3,225	980,296	304	674,000	68.7 †
14. Cracow	17,448	1,990,399	114	1,850,838	93.0
15. Lwów	27,024	2,718,856	101	1,525,751	56.1
16. Stanislawów	18,368	1,348,481	73	294,381	21.8
17. Tarnopol	16,240	1,429,627	88	633,948	44.3
18. Silesia (Cieszyn)	1,009	145,232	144	110,756	76.3
Poland	387,826	26,852,244*	69	18,377,218	68.4

* Including military population (318,452) the total is 27,170,696.

† The percentage of Poles in Upper Silesia is according to the German census of 1910.

In respect of area Poland occupies the sixth rank among the European states (after Russia, France, Spain, Germany, and Sweden) and also the sixth in respect of population (after Russia, Germany, England, France, and Italy) but only the twelfth as regards density of population (after Belgium, Holland, England, Germany, Italy, Czechoslovakia, Switzerland, Hungary, Denmark, Austria, and France, which last with a density of 71 inhabitants per square kilometer does not greatly surpass Poland).

[5] The provisional Polish-Lithuanian boundary drawn up in February by the League of Nations but protested against by Lithuania was confirmed by the Conference of Ambassadors, March 14, 1923. The boundary of eastern Galicia was confirmed at the same time.—Edit. Note.

Density of Population

Considering the size of the Polish provinces, the largest of which has an area equal to that of Switzerland, the contrasts in population density certainly claim attention—a density equal to that of Belgium on the one hand,

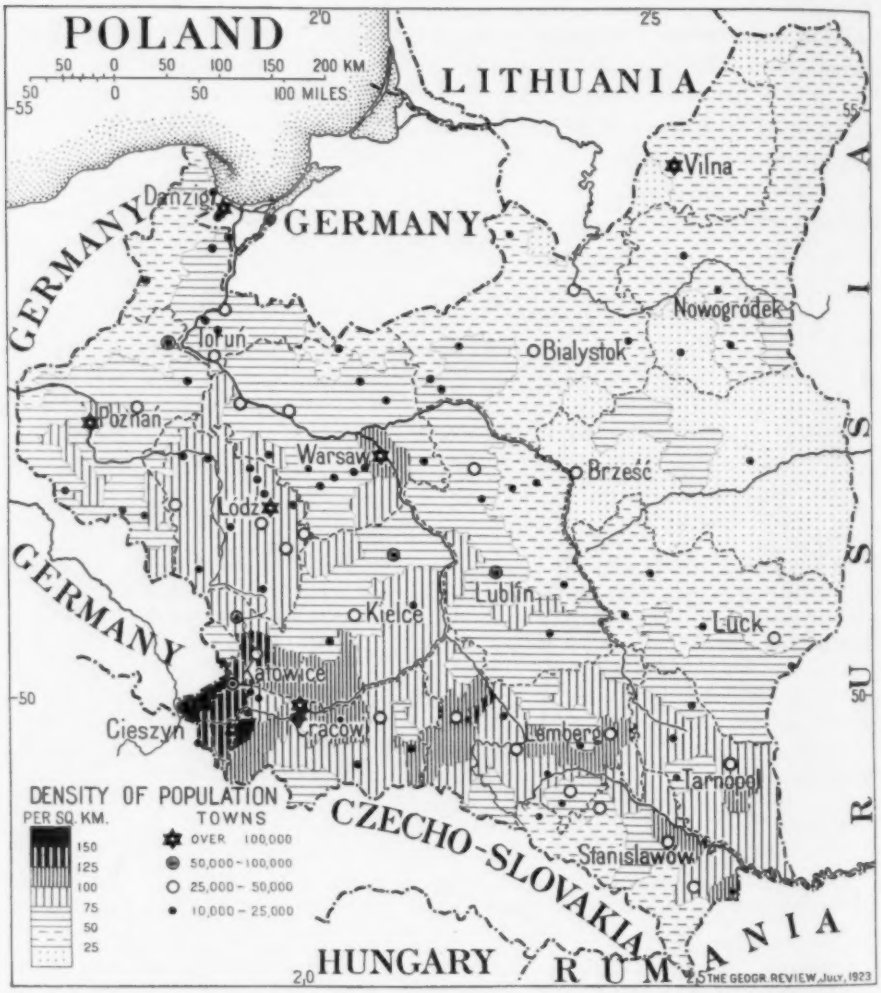

FIG. 1—The distribution of population in Poland according to the census of 1921. Towns of over 10,000 population are shown and the density of population exclusive of these towns. It is impossible to show all the towns in the mining districts of Upper Silesia and its borders. The German Census of 1919 gave 19 places of population of over 10,000 in the area of Upper Silesia awarded to Poland. Scale of map 1: 7,000,000.

that of Russia on the other. The greatest densities (more than 100 persons per square kilometer) are concentrated in the southwest, the smallest in the northeast.

The cartogram, Figure 1, shows details of the population distribution in

Poland, towns of over 10,000 population being eliminated. The first striking feature is the increasing concentration as one proceeds from east to west. In the degree that the areal base of national life becomes broader its pulsation weakens, and the density of population decreases; inversely, it increases according as this base, limited by the Baltic and the Carpathians, narrows in the west. This is especially notable in the western Carpathians, a region of no great agricultural development, without any important mining industries, yet more populous than the plains about the capital.

This broad statement of distribution is modified in detail by the operation of other more general factors. The greatest concentration in the west is in response to the geological factor—the coal fields and their related industries; in the east it reflects the distribution of loess and chernoziom (black earth). The sparse population of a rather considerable area in northwestern Pomerania is easily accounted for by the barren glacial and postglacial sands.

The Town Population

The urban population is considered as that dwelling in places of over 10,000 people. The geographical situation of these towns is indicated in Figure 1.

Among the forty towns of more than 25,000 inhabitants, seven are situated on the Vistula, seven in the region of economic contrasts on the border of the Carpathians, six on the coal fields, and five have been created by industry dependent on coal. The other towns are situated at communication centers, at old highroad crossings now railway junctions, often on the greater rivers. Radom (department of Kielce) is the only exception in this category, as it is no railway junction.

There are few towns in Poland. The urban population forms scarcely one-fourth of the whole number, and, if we take into consideration the fact that the population of hundreds of settlements now decayed has been included in this percentage, the proportion will prove to be still smaller. Thus among 642 settlements with municipal by-laws there are only 128 that have more than 10,000 inhabitants, the rest of these so-called towns having an average of 3000.

Table II shows the considerable differences between the number of towns in the eastern and western sections of the country.

Table II—Number of Towns of Given Population in Western and Eastern Poland

Region	10,000–25,000 Inhabitants	25,000–50,000 Inhabitants	50,000–100,000 Inhabitants	More than 100,000 Inhabitants
West	66	24	6	5
East	22	3	1	1

Number and Distribution of Poles

The census of 1921 registered a long list of cultural classifications—among them creed, mother tongue, and nationality. As to the latter, two categories only have been calculated hitherto: "Poles" and "other nationalities."

Figure 2 illustrates the distribution of Poles—a picture quite different from that given by the official censuses of the occupying powers. The differences between the new ethnographical picture and the old one are only quantitative for the west, both quantitative and qualitative for the east. In the west the percentage of Poles generally surpasses 90; it decreases to 75–50 in the districts on the Noteć, where the former maps showed a German majority. Our diagram shows also that the Polish majority not only

Table III—Percentage Distribution of Poles: Number of Districts

Census	0–10 Per cent	10–25 Per cent	25–50 Per cent	50–75 Per cent	75–90 Per cent	Over 90 Per cent
Of the occupying powers . . .	34	16	52	52	74	28
Polish census 1921	3	25	42	43	76	80

reaches the river Bug practically throughout its course (quite otherwise in the old maps) but also forms a large compact peninsula in the northeastern provinces, Bialystok, Wilno, and Nowogródek. Even in the three outermost districts on the Dvina (Braslaw, Dzisna, and Swieciany) the Poles form the most numerous element of the population. The only trait common to the new ethnographical picture and the former ones is the Polish minority in the southeast. But there also considerable areas with a Polish majority are found, as in Wolhynia and Podolia along the rivers Bug-Prypeć and in the surroundings of Lwów and Tarnopol; and a great majority of the more populated districts therein do not count much less than 50 per cent of Poles. Only in the waste fens of Polesie and the interior of the eastern Carpathians are there extensive areas with less than 25 per cent of Poles. In three districts only are there less than 10 per cent of Poles.

The figures in Table III summarize the differences in the ethnographical picture of Poland as given by the administration of the occupying powers before the war and by the 1921 census respectively.

The number of districts with less than 10 per cent of Poles has diminished to one-eleventh; that of the districts with more than 90 per cent of Poles has increased threefold. Furthermore, according to the former censuses all districts with more than 90 per cent of Poles, only two being excepted, were in Galicia, whereas according to the new census there are 56 such districts outside of Galicia. Thus the number of these districts with maximum percentage of Poles increased 28 times as compared with the pre-war figures!

Figure 3 illustrates the geographical distribution of these ethnographical

changes. Three well-defined areas may be distinguished. The first comprises the whole territory that belonged to Austria, chiefly its western part where the percentage of Poles has generally decreased. In eastern Galicia, where one would expect this decrease to be strongest, it is in reality the smallest, and considerable tracts even show an increase. In western Galicia, which is Polish to the core and comprised even in pre-war time the greatest number of districts with more than 90 per cent of Poles, this decrease is more formal than real. It is caused by the secession on a large scale of the Jews who hitherto professed Polish nationality, as the Austrian statistics did not recognize the Jews as a race. This fact may in itself be taken as a fair proof of the impartial nature of the last census.

FIG. 2

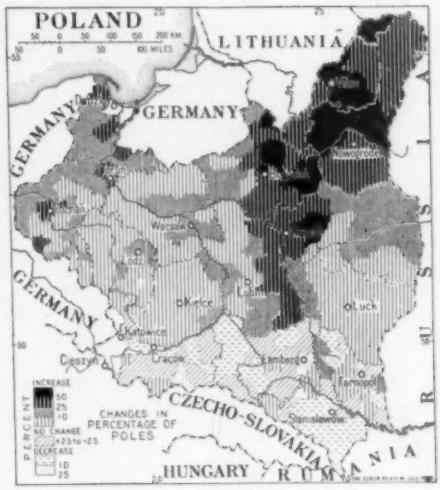

FIG. 3

FIG. 2—Percentage of Poles in the total population of Poland. Scale of map 1:14,500,000.
FIG. 3—Changes in percentage of the Poles in the total population before and after the war—1910 for German and Austrian Poland and 1897 for Russian Poland and 1921 respectively.

The rest of Poland shows a considerable increase of percentage of Polish inhabitants. Nevertheless, two different areas of general increase may be distinguished. One of them comprises the former Prussian provinces and the greater part of former Congress Poland; to the other belongs its eastern part and the whole northeastern section of the country. Wolhynia, however, should be classed with the first group where the increase, though general, nowhere attains an enormous degree; it oscillates between 5 and 25 per cent. A certain abnormal increase may be remarked in Pomerania and in the frontier districts of the province of Poznań.

But it is only in the northeast and all along the river Bug that the last census offers really enormous rates of increase of Polish population. One may in fact speak not of an increase but of a sudden and complete ethnographical change; for a territory which, according to Russian statistics,

was *not* Polish, proves now to be *only* Polish. This fact was stated in 1916 and 1918[6] by the German authorities in occupation, by whom, however, it was carefully hushed up; and afterwards by the Polish administration in December, 1919.[7] Yet it can hardly be described as a surprising revelation, for it had been foreseen by impartial foreign scholars.[8]

The Changes of the Population Caused by the War

Though many differences between the former ethnographical picture of Poland and the recent one may be ascribed to such falsifications, others must be explained by movements and transformations of population caused by the Great War. Their dimensions can be calculated for the former

FIG. 4

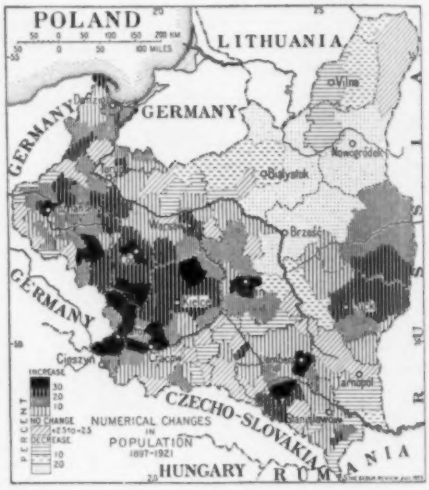

FIG. 5

FIG. 4—Numerical changes in total population of former German and Austrian Poland (Poznán, Pomerania, Silesia, Galicia) before and after the war—1910 and 1921 respectively. Scale of map 1:14,500,000.

FIG. 5—Numerical changes in total population of Poland during the last twenty-five years.

Austrian and Prussian territories by comparing conditions of 1921 with those of 1910.

Figure 4 illustrates these conditions. The movement of population in former Galicia and the adjacent part of Silesia proves that the whole area has suffered considerable devastation. Only the coal fields and the industrial districts near Cracow show a greater or smaller increase of population during the period 1910–1921; but farther to the east, where the fighting was fiercer and longer sustained, the decrease becomes still more considerable. It is

[6] The Eastern Border of Poland, Paris, 1919. Polish Comm. of Works Preparatory to the Peace Conference.

[7] Eugene Romer: Statistics of Languages of the Provinces Being Under Polish "Civil Administration of the Eastern Lands" (December, 1919), *Geographical Works, Memoir No. 7.* Lwów and Warsaw, 1920. (In Polish, French, and English.)

[8] "There is much reason to suppose that if ever an honest census is taken here, the eastern limits of the Polish ethnographic area will be extended considerably beyond the boundaries of the Congress Kingdom" (C. H. Haskins and R. H. Lord: Some Problems of the Peace Conference, Cambridge, Mass., 1920, p. 159).

also clearly apparent that the mountains, affording a natural shelter, have been less depopulated than the plains of the north. Before the war parts of this area showed marked natural increase, and in cases where decrease was registered it was explained by excess of emigration over natural increase.[9] It may then be calculated that a great number of districts in eastern and southeastern Galicia must have lost about 30 per cent of their population through the devastations of war. There are many indications that the losses inflicted by the war have weighed more heavily on the Ruthenian population (or "Ukrainian" as they have called themselves for some time) than on the Polish element, which defended itself vigorously against the evacuations organized in Galicia and Congress Poland by the retreating Russian armies.

Figure 4 is still more illuminating as regards the movements of population between 1910 and 1921 in the former Prussian provinces. It appears that the Polish center of this territory, where the officially directed German colonization had not yet penetrated to any great extent, not only suffered no decrease but even shows a distinct increase of population for that period. The fact that all districts situated on the German frontier and nearly all Pomerania, especially the territory on the Noteć, colonized by the Germans systematically and intensively since the time of Frederick II, have suffered general and severe losses, throws a light on the cause of these contrasts. The German settlers, owing all their welfare to the state and brought up in obedience to it, spontaneously made far greater sacrifices than the Poles who succeeded in avoiding the burdens imposed by the war. This circumstance, together with the remigration of German colonists and the influx of Poles from other sections of the country, explains the shiftings of population in the former Prussian provinces during the war and at the same time the considerable increase of the Polish element inhabiting them.

Besides the actual loss of German population a factor of entirely different order has influenced the comparative increase of Polish population. The researches of Andrzejewski,[10] published on the eve of the signing of the peace treaties, showed that from 25 to 35 per cent of the German inhabitants of Prussian Poland were dependent on the state, as colonists and officials. According to his calculations more than 50 per cent of the German population of 17 districts and 75 per cent of that of four other districts were more or less materially dependent on the Prussian government. It is quite natural that this class should participate most largely in the remigration to Germany. Yet on further consideration it appears that the remigration from the provinces of Poznań and Pomerania does not agree with the statements of Andrzejewski. It is easily conceivable that among the German population counted previously by the Prussian census there had been a great number of Poles who only adhered to their nationality in the census of 1921. Before

[9] Romer, Atlas de la Pologne, 1916, Pl. VIII; 2nd edit., 1921, Pl. IX.

[10] Liber (Andrzejewski): Das Deutschtum in Westpolen, Poznań, 1919; E. Romer: Population allemande en dépendance du gouvernement prussien, Paris, 1919; Isaiah Bowman: The New World, New York, 1921, p. 338.

the war often only school children dared to do so, hence the difference between the results of official Prussian censuses and those of official statistics of the mother tongue of school children.

In default of a Russian census corresponding to those for Germany and Austria it is impossible to evaluate the corresponding losses and shiftings of population caused by the war in former Russian Poland. However, the wish to solve at least in some measure the interesting problem of the war losses in this section of the country led me to an approximate calculation based on an interpolation between the Russian census of 1897 (the sole basis for demographic research) and the Polish one of 1921, arrived at by comparison with the Austrian and Prussian censuses of 1900, 1905, and 1910.

Numerical Changes of Population During the Last 25 Years

The calculated movement of population in the last 25 years is shown in Figure 5. The results are really unexpected. In this picture there is only one zone of devastation, a broad belt beginning in the northeast, comprising the whole province of Bialystok, a part of the provinces Wilno and Nowogródek, and growing narrower towards south-southeast, across the eastern part of the province of Lublin and the west of the provinces of Polesie and Wolhynia. The traces of this zone of devastation are visible in the extreme east of former eastern Galicia (provinces of Tarnopol and Stanislawów). The whole zone, which is generally speaking identical with that of long-lasting combats, frequent strategic shiftings, and the evacuations connected with them, shows a really dreadful depopulation. Full particulars will be known only after the publication of the detailed results of the census for the different localities; but it can be stated now that this zone, the poorest of Poland as regards natural resources and degree of civilization, has suffered most cruelly from the devastations of the war.

Depopulation in Poland and in France Compared

The facts are as follows: the area of German invasion in France comprised the *départements* Aisne, Ardennes, Marne, Meurthe et Moselle, Meuse, Nord, Pas de Calais, Somme, Vosges.[11] This area of 57,112 square kilometers counted 6,112,000 inhabitants in 1911 and only 5,392,000 in 1921, a loss amounting to 720,000 persons, i.e. 11.7 per cent of the population of 1911.

The area of devastation in Poland is much greater. If we set aside the provinces of Wilno and Nowogródek because of difficulties of comparison on account of the changed system of administration, there remain 52,457 square kilometers in the provinces of Bialystok, Lublin, Polesie, and Wolhynia where the number of inhabitants was 2,479,900 in 1897 as against 1,905,200 in 1921, i.e. the population loss with relation to 1897 amounts

[11] Maurice Zimmermann: La population de la France en 1921, *Ann. de Géogr.*, Vol. 31, 1922, pp. 37–51; reference on p. 39.

to 23 per cent. Considering that the natural increase of this population was at least one and a half per cent per annum, or 26 per cent at the outbreak of war and 37 per cent up to the year 1921, it is quite certain that since 1914 at least 39 per cent of inhabitants of this territory have disappeared, or 43 per cent if one allows for loss of natural increase during the war. Similar calculations concerning the center of this area of devastation, that is the districts of Bialowieza, Bielsk, Brześć, Drohiczyn, Kobryń, and Pruzana, show that the 1921 population is scarcely one-half of that of 1914.

Fortunately, a considerable part of these losses may probably be ascribed to the evacuations which were organized on a large scale at every retreat, especially during the first defeats of the Russian armies. In the Russian chaos beginning soon afterwards the fate of the homeless masses was of course little better than death.

Without taking into account the systematic falsifications committed by the Russian administration in 1897, one must not overlook the fact that the depopulation of the above-mentioned zone was largely among Ruthenians and White Russians, that is the population of Orthodox faith, and therefore greatly contributed to the reinforcement of the Polish and Catholic element of this territory.

On Vast Territories No Marked Traces of War

Outside the zone discussed above there is another result of this demographic analysis that also, in some measure, is unexpected. Not only to the west of the zone of great devastations but also eastward, especially in the fen country of Polesie and in the northern part of Wolhynia, the ravages of war did not destroy the considerable natural increment of the population.

Similar conditions obtain to the west; above all, in the western part of the province of Lublin and in the part of the former Congress Kingdom which is situated westward of the Vistula, where the war seems to have left no traces at all in the population movement. A comparison with a map of annual increase of population in pre-war Poland[12] with Figure 5 shows that westward of the zone of great devastations the war did not alter the regional peculiarities of the population. The territories of pre-war emigration appear also in the new picture as areas of decrease, and those of pre-war immigration as areas of increase. In short, the Great War caused only quantitative modifications of these movements westward of the rivers Bug and Narew, but it did not alter them essentially, that is, qualitatively.

Causes of the Increased Percentage of Poles

The reality of the extraordinary ethnographic changes in the eastern and western border territories appears to be sufficiently well explained by the causes given above—in the east, falsifications of the official pre-war census and shiftings on a large scale of the population; in the west, the same

[12] Romer, Atlas de la Pologne, 1916, Pl. VIII; 2nd edit., 1921, Pl. IX.

causes together with the fact that Polish officials, remaining in the service of the state, might openly adhere to their nationality.

The increase of the percentage of Poles in the territory of former Congress Poland is easily accounted for by the same processes and causes advanced for the provinces of Poznań and Pomerania. It is, however, remarkable that a considerable part of this increase is due to the Jewish inhabitants professing themselves Poles. On the other hand, there are signs that the percentages of the Jewish population stated by the census of 1897 are much greater than the real ones. The above-mentioned researches of Szulc[13] prove that the number of inhabitants calculated by the Russian administration was always higher than the real one and that this surplus increased with every new calculation, as the unsettled inhabitants (for the most part Jews) were often counted twice by the incompetent officials. Hence the conclusion that the number and percentage of the Jewish population is the most uncertain and exaggerated figure of the official Russian statistics.

The Poles in Galicia

We have already mentioned that former Galicia is the only area in Poland where the percentage of Poles underwent a more or less general decrease and have explained it for certain sections by the fact that the Jews could now declare their nationality. Yet a survey of the ethnographic changes in former Galicia, especially in its eastern part, is too important to be passed over without further discussion. Some light is thrown on the question by the school census of December 1, 1921, taken in the whole of Poland. It has been published hitherto only for the province of Poznań. Besides the figures for this province there are at my disposal materials for all the provinces of former Galicia (Cracow, Lwów, Stanislawów, Tarnopol).

During the whole period of peace negotiations in Paris the Polish delegation energetically contested the results of the censuses taken by the occupying powers. As regards former Prussian Poland, the official Prussian census of population was contrasted with the Prussian school census, the results of which were considered less falsified. We are now able to furnish the proof that this assertion of the Polish delegation was correct and that the school census, if based consistently on a compulsory school attendance can replace in some measure the census of population. At the same time we are furnished with proof of the objective character of the Polish census and school census.

Let us consider the figures. According to the Prussian census of 1910 the percentage of Polish population in the former regency of Poznań was only 61, whereas the Prussian school census of 1911 stated that 77 per cent of the school children were Polish. In contrast with this difference in the figures, the Polish census of 1921 indicated 82.5 per cent for the whole of

[13] Szulc, *loc. cit.*, p. 31. See also W. Wakar: Rozwój terytorjalny narodowosci polskiej (The Territorial Development of the Polish Nationality), Warsaw, 1907, Vol. 1, pp. 80–91.

the Polish population in the province of Poznań and 82.1 per cent for the Polish school children there.

These numbers invite a closer analysis of the school census taken in the Galician provinces. It must be remarked, however, that this school census was restricted to the registration of creed, although the regulations had prescribed statistics both of creed and of nationality. The schoolmasters, to whom the school census had been entrusted, evidently identified nationality with creed, namely Jewish, Ruthenian, and Polish nationality with Hebrew, Greek Catholic, and Roman Catholic faith respectively. Only sporadically did they take account of Roman Catholic Germans. A careful examination of the lists gives the impression that no notice was taken of an adherence to Polish nationality if it was not accompanied by Roman Catholic or Protestant faith.

Table IV gives a comparative view of the results of the census of population and the school census.

TABLE IV—NATIONALITY AND CREED IN GALICIA*
(*Percentage*)

PROVINCE	POLES		ROMAN CATHOLICS		HEBREWS	
	1910	1921	1910	1921	1910	1921
Cracow	95.9	93.0	89.0	91.1	7.8	6.4
Lwów	60.2	56.1	45.2	50.1	12.3	10.4
Stanislawów . . .	25.3	21.8	13.3	21.1	12.2	11.6
Tarnopol	41.0	44.0	28.7	34.0	11.7	11.0

* Figures for 1921 for Roman Catholics and Jews are from the school census.

The table shows a distinct decrease of the percentage of Poles in the whole of former Galicia except in the province of Tarnopol, situated in the extreme east. It is not difficult to find the cause of the high percentage of Poles in 1910. It is approximately equal to the sum of the percentage of Roman Catholics and that of Hebrews. The middle columns (Roman Catholics) show that the essential part of the Polish nationality in former Galicia not only did not weaken in 1921 but, on the contrary, increased rather strongly.

TABLE V—CHANGE IN PERCENTAGE OF ROMAN CATHOLICS 1910–1921 ACCORDING TO THE CENSUS OF POPULATION AND THE SCHOOL CENSUS (*By Number of Districts*)

PROVINCE	DECREASE		INCREASE			More than 10
	5–2.5	2.5–0	0–2.5	2.5–5	5–10	
Cracow	1	6	7	6	3	–
Lwów	–	1	12	10	4	1
Stanislawów . . .	–	1	1	6	6	2
Tarnopol	–	–	3	3	6	4
Former Galicia .	1	8	23	25	19	7

The number and distribution of districts showing an increase of Roman Catholic population are an incontestable argument that these ethnic changes have been the result of movements of population caused by war and evacuations.

Economic Importance of the Polish Census

The census of 1921 was a bold enterprise and a notable contribution to national civilization. This assertion will not seem exaggerated if we consider

FIG. 6

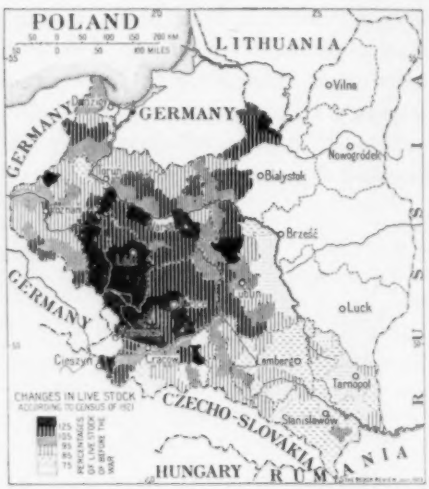

FIG. 7

FIG. 6—Number of head of live stock ("large cattle," see text for explanation of unit) in Poland per 100 inhabitants. Scale of map 1:14,500,000.

FIG. 7—Changes in number of live stock before and after the war.

that an administration just beginning to function and meeting extraordinary difficulties undertook not only the census of the inhabitants with a complete demographic analysis but also that of domestic animals and agriculture. The drawback of this great enterprise is that several years must elapse before the detailed results will be known, and doubts have been expressed as to whether the Polish administration was equal to a task of such magnitude. At least a partial reassurance may be found in an examination of the provisional results of the census of domestic animals which have been already published.

For the whole of the former Russian territory, Congress Poland included, the Polish census of domestic animals is the first of its kind. The Russian statistics were based upon estimates made by the Ministry of the Interior and the Ministry of Agriculture. Their estimates differed for some governments as much as 75 per cent and on the average 25 per cent. They were limited to governments for the whole of Russia, except Congress Poland.[14]

[14] Romer, Atlas de la Pologne, 1916, Pls. XXV–XXVII; 2nd edit., 1921, Pls. XXVII–XXIX.

TABLE VI—DOMESTIC ANIMALS IN POLAND ACCORDING TO THE CENSUS OF 1921

PROVINCE	HORSES	HORNED CATTLE	SHEEP	SWINE	"LARGE CATTLE"
Former Congress Kingdom	1,306,845	3,021,319	725,277	1,816,299	4,963,583
Frontier Territories in the East	619,411	1,257,771	542,370	964,999	2,254,024
Poznań, Pomerania	418,190	1,265,363	621,795	1,396,383	2,188,097
Former Galicia	850,969	2,309,989	281,054	946,437	3,467,833
Poland (without Wilno and Silesia)	3,195,415	7,854,442	2,170,496	5,124,218	12,873,537

To give the results of the census of domestic animals in a short and comprehensive form, I have calculated the number of "large cattle" by counting horses and horned cattle as units and sheep, swine, and goats as quarters of a unit. In this way the sum of domestic animals is expressed without any reference to their species. Figure 6 gives a picture of the number of domestic animals reduced to these units and expressed in per cent of the number of inhabitants for each district. There are no data for the Polish part of Prussian Silesia and for the province of Wilno. The detailed figures are as in Table VI.

TABLE VII—DOMESTIC ANIMALS PER 100 INHABITANTS IN POLISH PROVINCES BEFORE AND AFTER THE WAR

(*Figures before the war in roman type, after the war in bold-face type*)

PROVINCE	HORSES	HORNED CATTLE	SHEEP	SWINE	"LARGE CATTLE"
Former Congress Kingdom	8.8 **11.6**	15.0 **26.9**	6.7 **6.5**	3.9 **16.2**	26.4 **44.2**
Frontier Territories in the East	15.4 **17.1**	32.5 **34.8**	22.5 **15.0**	17.2 **26.7**	57.9 **62.4**
Poznań, Pomerania	14.8 **14.4**	42.5 **43.5**	23.5 **21.4**	53.0 **47.9**	76.4 **75.2**
Former Galicia	11.2 **11.2**	30.6 **30.6**	4.6 **3.8**	22.2 **12.5**	48.1 **45.8**

Setting aside the provinces of Poznań and Pomerania, which are particularly rich in live stock, the rest of Polish territory shows a uniformity of distribution of domestic animals that has been hitherto unrealized. Furthermore, the contrasts between the extreme west and the rest of Poland are incomparably less pronounced than we thought them to be.[15]

[15] Romer, Atlas de la Pologne, 1916, Pls. XXV–XXVII; 2nd edit., Pls. XXVII–XXIX. See also V. C. Finch and O. E. Baker: Geography of the World's Agriculture, U. S. Dept. of Agric., Washington, D. C., 1917, Figs. 165, 177, 179, and especially 191.

The numbers of domestic animals, before and after the war, expressed in per cent of the population of the different Polish provinces, are as in Table VII. The upper row of figures for each province is according to prewar official statistics, the lower row (in bold-faced type) is according to the census of 1921. The differences expressed as percentage are shown in Figure 7.

Considering the table one cannot do otherwise than draw the conclusion that all pre-war figures concerning Congress Poland and the eastern Polish territories, that is the former Russian provinces, have been completely valueless. For is it possible that in the former Congress Kingdom the stock of horses and horned cattle has increased *during the war* by 30–50 per cent compared with the pre-war stock? And that it increased considerably, if less rapidly, in the east, which has been so terribly devastated by the war?

For great areas which were under Russian administration the Polish census of 1921 unquestionably gives the first correct statistics of the economic life of the country as well as of its demography.

FLOOD AND EBB IN NEW YORK HARBOR

By H. A. MARMER

U. S. Coast and Geodetic Survey, Department of Commerce

The great ports of the world, almost without exception, are situated on tidal waters. Some of these ports are many miles from the sea—London 50 miles from the mouth of the Thames, Hamburg 75 miles up the Elbe—and to reach them the ship-borne traffic of foreign and domestic commerce must traverse the tidal waters that connect these ports with the open ocean. These tidal waters thus serve as highways to the seven seas, and for each port the tidal régime in the channel that connects it with the open ocean is a matter of considerable importance.

In the days of the shallow-draft ship the highway leading from the sea did not possess the importance attaching to it today. Cologne, 210 miles up the Rhine, was in medieval times one of the great Hanseatic seaports, although the channel at that time was less than six feet in depth.[1] But the introduction of steam as the propelling power and the advent of the iron and steel ship, together with the enormous increase in world-wide trade brought about by the industrial development of the past century, make the channel leading to the sea a feature of first importance in the modern harbor.

The time required for a sailing vessel to cross the ocean, together with its dependence on wind and weather, made impossible the maintenance of an exact schedule for arrival and departure. If the channel leading to the harbor was not sufficiently deep to permit entrance at low water the delay of six hours awaiting high water was not a serious matter, for this delay represented but a very small fraction of the time of the voyage. Now with the time of crossing the ocean counted in days and with a transatlantic liner representing an initial investment of several million dollars, a delay of as much as a quarter of a day at each end may mean the difference between profit and loss. For the profit from the modern leviathan—costly in build and costly in operation as a unit—depends on the number of trips it can make a year.

The advent of the iron and steel steamer removed the limitation on the size of ships that wood construction had imposed. The larger ship is also the more profitable one to operate, provided the traffic is sufficiently large. And, where the stream of traffic was sufficient, as in the transatlantic trade, the shipping industry responded with larger and larger vessels. The White Star liner *Majestic*, the largest passenger ship, may be taken as type. Having a length of nearly 1000 feet, a width of 100 feet, and a gross tonnage of 56,000 tons she carries a crew numbering almost 1100 and requires a

[1] E. J. Clapp: The Port of Hamburg, New Haven, 1911, p. 30.

channel depth of not less than 40 feet. As she steams for the harbor of New York at her normal speed of 575 miles per day the *Majestic* is a far cry from the *Half Moon* of 80 tons' burden and draft of 7 feet, which with a crew of 18 or 20 men Henry Hudson sailed into the same harbor but a little over three centuries ago.

To permit the deep-draught vessels of modern commerce to enter port enormous sums have been expended in the effort to maintain a sufficient depth in the channels connecting the seaports of the world with the open ocean. The ideal channel is one sufficiently deep to permit all vessels to enter port at any stage of the tide. Where this ideal was impracticable of

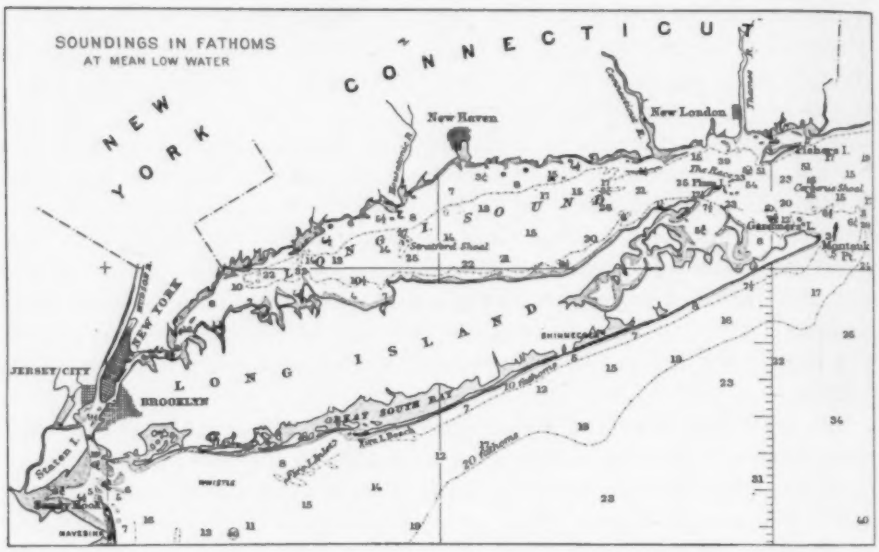

FIG. 1—New York Harbor, showing the two ocean entrances. Reduced from *U. S. Coast and Geodetic Survey Chart No. 1000.*

realization it has frequently been found necessary to construct a sub-port or twin port closer to sea somewhere along the channel. Obviously this entails extra expense in bringing up the ship-borne traffic, either by rail or by lighter, from the lower sub-port. Despite this, examples of twin ports are not uncommon in Europe. To mention but the more prominent ones we may cite London and Tillbury, Hamburg and Cuxhaven, Bremen and Bremerhaven.

The tide is the bond that keeps the channel leading to the port in intimate contact with the open sea and its vivifying influences. And the extent of rise and fall of tide in the channel is the factor that frequently determines the type of harbor that must be developed. If the rise and fall of the tide, or more precisely the range of the tide, is over fifteen feet the closed-dock type of harbor generally results. This is exemplified by London with a tidal range of 16 to 21 feet and by Liverpool with a range of 15 to 27 feet.

A large vessel rising and falling with the tide fifteen feet or more twice each day presents a number of problems in loading and unloading. Furthermore, the erection of suitable wharf structures would entail considerable expense. The result in such cases is therefore the closed-dock harbor in which the docks are entered through locks open for a few hours about the time of high water.

Where the rise and fall of the tide is less than fifteen feet and the channel is sufficiently deep the open-basin type of harbor results. In this case piers may be constructed directly into the channel, and a vessel may dock at all stages of the tide, obviating the delay arising in the closed-dock harbor which can be entered or left only near the time of high water. In this

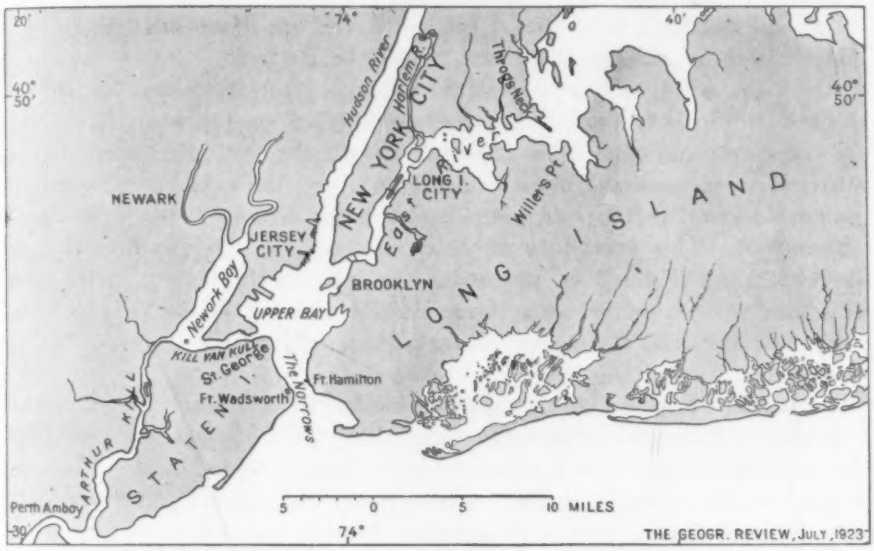

FIG. 2—New York Harbor, showing the relations of the component parts, Upper Bay Kill van Kull, East River, Harlem River, and Hudson River.

regard all the great American ports are fortunately situated, the range of the tide generally being less than ten feet.

THE HARBOR OF NEW YORK

Unlike other harbors which generally consist of a tidal bay or river, New York Harbor comprises a system of five tidal highways that connect with the sea by means of two inlets many miles apart. Figure 1 shows the position of New York Harbor with regard to the ocean, and Figure 2, on a larger scale, shows the relations of the various parts of the harbor to each other. The principal entrance to the harbor is the southerly one past the Narrows, which is the gateway of important trade routes. Through the Narrows come the ships from all the ocean highways, and through this same funnel the exports of a great hinterland, reaching back of the Alleghanies, find their way into the channels of international trade. Past this

gateway the largest ships afloat may steam into the harbor at any stage of the tide.

The Narrows leads into Upper Bay, a sheet of water having an area of about 20 square miles; and from this bay three tidal highways radiate. Toward the west Kill van Kull, a short strait, connects with Newark Bay; toward the east East River, a strait about 15 miles long, leads to Long Island Sound, the eastern entrance from the ocean to New York Harbor; and into the northern end flow the waters of the Hudson, a tidal river that drains a territory of some 13,000 square miles. Harlem River, the fifth of the waterways, is a strait about 7 miles long connecting East River with the Hudson. New York Harbor may therefore be taken as consisting of Upper Bay, Kill van Kull, East River, Harlem River, and Hudson River from its mouth to Spuyten Duyvil where it meets the Harlem.

It is obvious that a case may be made out for including, as parts of New York Harbor, Newark Bay and Arthur Kill on the west, Lower Bay on the south, and even Long Island Sound on the east. However, the five waterways enumerated above constitute New York Harbor as usually understood and for the purposes of this paper will be taken to comprise the harbor. This procedure may be justified, too, by the fact that an understanding of the tidal phenomena in New York Harbor, in the more restricted sense used here, may be arrived at without the need of discussing in detail the tidal régime in Newark Bay, Arthur Kill, Lower Bay, or Long Island Sound.

A glance at Figure 1 shows that the tide from the Atlantic Ocean reaches the harbor of New York from two directions. From the east the ocean tide enters East River after traversing Long Island Sound, while from the south the tide sweeps into the Narrows past Sandy Hook and Lower Bay. There is, to be sure, another channel for the tide, namely, from Lower Bay through Arthur Kill into Newark Bay and thence through Kill van Kull into Upper Bay. But the Narrows affords a much shorter and a very much more commodious channel, so that relatively very little of the ocean tide finds its way into the harbor by way of Arthur Kill. The tidal gateways to New York Harbor may therefore be said to be located at Throgs Neck on the East and at Fort Wadsworth on the south.

Into New York Harbor, therefore, the ocean tide finds its way through two inlets many miles apart. This in itself makes possible some variety in the tidal phenomena of the harbor; but still further variety is brought about by the fact that the five component parts which constitute the harbor are either intercommunicating or lead into other waters, so that the tide in one part may be affected by the tide in another.

Tides and Tidal Currents

The response of the ocean to the tide-producing forces of sun and moon is of a two-fold character—there is a vertical rise and fall of the water, and there is also a horizontal movement forward and backward. To distinguish

between the two movements the vertical rise and fall is called the "tide," and the horizontal forward and backward movement is called the "tidal current." For convenience the two movements of the water taken together are commonly called the "tide" or "flood and ebb."

In navigation the vertical rise and fall of the tide is a matter of prime importance in the immediate vicinity of the coast or in areas of shoal water. Out in the open sea, however, the vertical rise and fall may be totally disregarded by the navigator, but the horizontal movement of the water is still a matter of practical importance. Furthermore, out in the open the rise and fall of the tide is no longer obvious. Hence, when the mariner speaks of the "tide" he frequently has in mind the tidal current, as when he says "the tide is ebbing."

It is essential, however, to distinguish clearly between tide and tidal current, for the relation between the two is not a simple one nor is it everywhere the same. At one place we may find a strong current accompanying a tide having a very moderate rise and fall, while at another place a like rise and fall of the tide may be accompanied by a very weak current. Furthermore, the time relations between current and tide at different places are subject to wide variation. To avoid confusion, therefore, it is advisable to use "tide" in reference to the vertical movement of the water and "current" in reference to the horizontal movement.

In connection with the phenomena of the tides the terms "rise," "fall," "flood," and "ebb" are of frequent occurrence. The first two clearly pertain to the vertical movement of the water, and no confusion arises from their use. Flood and ebb, unfortunately, are made to refer indiscriminately either to the vertical movement or to the horizontal movement and, furthermore, to the general phenomena of the tides. In the latter use, to be sure, there is no danger of confusion, since the context indicates the meaning; but in such phrases as "the tide is ebbing" it is not at all clear whether a falling tide or an ebb current is meant. And it is to be noted that a rising tide does not necessarily imply an inward-flowing current, nor is a falling tide synonymous with an ebbing current. For the sake of clearness, flood should refer to the horizontal movement of the water toward the land or upstream, and ebb to the horizontal movement away from the land or downstream.

The Tide at the Southern Gateway

The tides in the Narrows, the southern gateway to New York Harbor, are quite well determined. For more than a quarter of a century an automatic tide gauge has been in operation at Fort Hamilton, furnishing a continuous record of the rise and fall of the water night and day, winter and summer. In its larger features, the tide in the Narrows is of a relatively uniform character from day to day; but a close examination shows certain variable characteristics. The varying positions of sun and moon in the heavens, the changing winds, unusual rainfall, freshets in the upper reaches

of the Hudson, and even changes in barometric pressure—all these variations are reflected in the rise and fall of the tide.

The moon plays the leading rôle in the production of the tide and makes the length of the tidal day the same as its own, namely, 24 hours and 50 minutes. It is therefore found convenient to express time relations of the tide with reference to the time of the moon's passage over the meridian of any given place. In Figure 3 the rise and fall of the tide at Fort Hamilton is shown with reference to the time of the moon's passage over the meridian

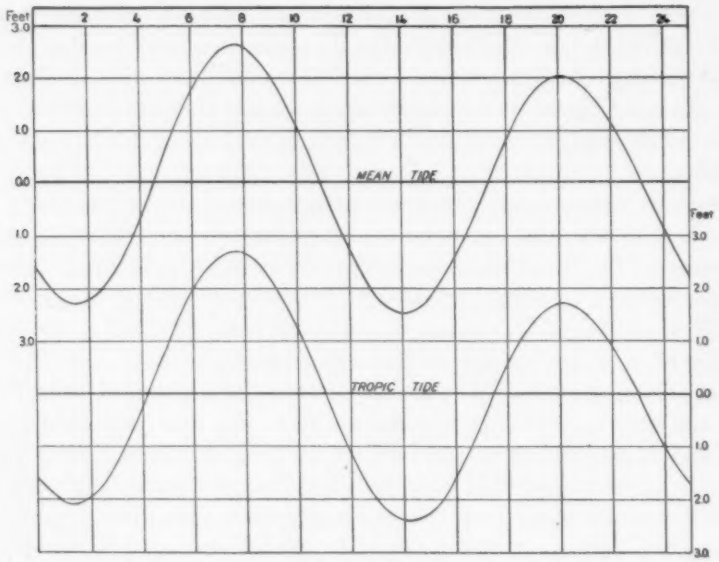

FIG. 3—Tide curves, Fort Hamilton, N. Y.

of Fort Hamilton, zero hours being the instant of the moon's passage over the meridian.

The upper diagram in Figure 3 represents the average conditions of the rise and fall of the tide at Fort Hamilton. A glance shows that in a tidal day, a period of 24 hours and 50 minutes, there are two complete cycles of rise and fall, giving in a day two high and two low waters. When the moon crosses the meridian of Fort Hamilton the tide is falling, and the fall continues an hour and 38 minutes longer, at which time low water is reached. The tide then begins rising, slowly at first, but at an increasing rate for about three hours, after which the rise takes place at a constantly decreasing rate for a like period of three hours until high water is reached, which occurs 7 hours 40 minutes after the moon has crossed the meridian. The average rise and fall of the tide, or the mean range of the tide, is 4.7 feet, the rise taking place in 6 hours and 2 minutes, and the fall in 6 hours and 23 minutes.

It is to be noted that the diagram represents average tidal conditions. Since the sun too is concerned in bringing about the rise and fall of the

water, the time of tide is not absolutely fixed with relation to the moon's meridian passage. If the lunar constituent could be restrained from interfering, the component of the tide which the sun brings about would produce high water at Fort Hamilton about eight o'clock both morning and evening. This solar tide has at Fort Hamilton a rise and fall of but one foot; nevertheless it affects both the time and height of the lunar tide. The intervals by which high and low water follow the moon's meridian passage are therefore somewhat variable, though it is to be noted that at Fort Hamilton this variation is only infrequently as much as an hour. It is to be noted, further, that as regards the tide the "moon's meridian passage" has a special significance. It refers not only to the instant when the moon is directly above the meridian but also to the instant when the moon is directly below the meridian, or 180° distant in longitude. In this sense there are two meridian passages of the moon in a tidal day, and they are distinguished by being referred to as the upper and lower meridian passages.

The zero line of heights in the curves of Figure 3 represents the plane of mean sea level, and it is seen from the mean tidal curve that the two low waters of a day fall to different depths below sea level and likewise that the two high waters of the day rise to different heights. This variation in the heights of the two high waters or the two low waters of a day, known as the diurnal inequality, is found to be related to the moon's declination or its distance north or south of the equator. The diurnal inequality is greatest when the moon has its maximum declination and least when the moon is over the equator. In other words, in a period of about fourteen days the diurnal inequality goes through a complete cycle.

The mean tidal curve shows that at Fort Hamilton the average difference in the heights of the two low waters of a day is two-tenths of a foot, while in the high waters this difference is six-tenths of a foot. When the moon has its greatest semimonthly north or south declination the diurnal inequality in the heights of high or low waters is at a maximum, and the tides at such times are called "tropic tides" since the moon is then near one of the tropics. The lower curve in Figure 3 shows the character of the tide at such times. It is seen that the low water inequality has been changed but little, being at such times three-tenths of a foot; the high water inequality, however, now becomes one foot. In other words, the diurnal inequality in the tide at Fort Hamilton—and also throughout New York Harbor—exists principally in the high waters.

At times of full and new moon the tidal forces of sun and moon conspire and bring about a rise and fall of the tide greater than the average—the tides at such times being called "spring tides." At Fort Hamilton at such times the tide has a range 20 per cent greater than the mean range, the average rise and fall of the tide then being 5.6 feet. At times of the moon's first and third quarters the tidal forces of sun and moon are opposed, the tides then being known as "neap tides." At such times the tide at Fort Hamilton has a range of 3.8 feet, or 20 per cent less than the mean range.

The distance of the moon from the earth likewise affects the range of the tide. In its movement around the earth the moon describes an ellipse in a period of about 27½ days. When the moon is in perigee, or nearest the earth, the mean range of the tide at Fort Hamilton is increased by 23 per cent, becoming 5.8 feet. When the moon is farthest from the earth, or in apogee, the mean range of the tide is decreased by 20 per cent, being then only 3.8 feet.

It is to be noted, however, that in its response to the variations in the position of the moon relative to the earth and sun, the tide at Fort Hamilton is about a day behind the moon; that is the range of the tide is greatest, not on the day of full moon, but a day later. Likewise the range of the tide is greatest about one day after the moon is in perigee, and it is by an interval of a day that the neap tides follow the moon's first and third quarters. This lag in the response of the tide is known as the "age of the tide" and is generally ascribed to the effects of friction.

Since the period from one full or new moon to another is 29½ days while the period from one perigee to another is 27½ days, it is obvious that there will be times when the moon will be full or new and also in perigee. At such times we should expect the tide to have its greatest range. In 1916 on July 15 the moon was full and also in perigee. A day later we should therefore expect to find the tide at Fort Hamilton to have an unusually large range; in fact, some 40 per cent greater than the average, 20 per cent increase being due to full moon and 23 per cent to the moon's perigee. On July 16, 1916, the tide at Fort Hamilton, as shown by the automatic tide-gauge record, rose and fell through a vertical distance of 6.5 feet or 39 per cent more than the average.

Likewise, unusually small ranges of the tide should occur when the moon happens to be in apogee at the same time that she is in her first or third quarter. The range should then be decreased 20 per cent from its mean value because of the moon's apogee and a further 20 per cent because of neap tide, or a total of 40 per cent. On October 19, 1916, the moon was in apogee and also in its third quarter; and on the next day the tide-gauge record at Fort Hamilton shows the range of the tide to have been 3.2 feet or about 32 per cent less than the mean range.

In addition to the changes due to celestial conditions noted above, the rise and fall of the tide at Fort Hamilton is also considerably influenced by terrestrial conditions. This is to be expected for two reasons. In the first place the mobility of the water permits the wind to affect the time and height of the tide; and in the second place the Narrows acts as a funnel through which there is discharged into the sea the fresh-water run-off from a territory nearly 15,000 square miles[2] in area. This fresh-water discharge varies throughout the year, depending on the variations in rainfall

[2] Main Drainage and Sewage Disposal Works Proposed for New York City: Reports of Experts and Data Relating to the Harbor, *Rept. Metropolitan Sewerage Commission of New York, April 30, 1914*, 762 pp.; reference on p. 558.

and also on freshet conditions in the Hudson River above the Battery. Since the variations in wind and rainfall are largely of a seasonal nature, the tides at Fort Hamilton should likewise exhibit a seasonal variation. This is shown in Figure 4, which represents in diagrammatic form the average heights of high water and low water each month of the year as determined from observations extending over a period of 19 years, from 1902 to 1920.

The vertical lines represent the average monthly rise and fall of the tide at Fort Hamilton for each month of the year, the upper end of each of these vertical lines showing the average monthly height of high water, while the lower end shows the average monthly height of low water. The dotted horizontal line joining the upper ends of the vertical lines therefore represents the monthly changes in the height of high water, and the lower dotted horizontal line likewise represents the monthly changes in the

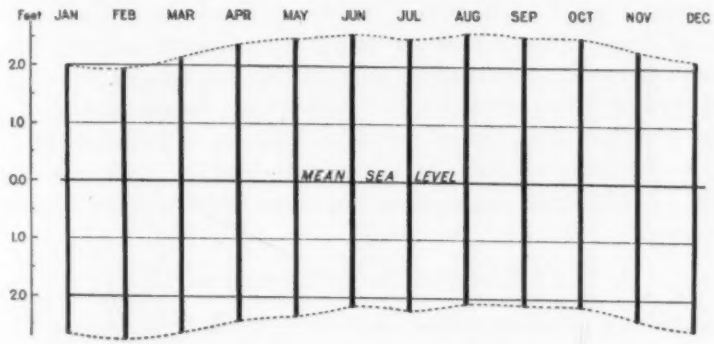

FIG. 4—Monthly variation in height of tide, Fort Hamilton, N. Y.

height of low water. It is important to note that the seasonal variation in the height of the tide is the same for both high and low waters. In other words, this seasonal variation does not affect the range of the tide, but it does bring about a corresponding seasonal variation in sea level at Fort Hamilton.

Figure 4 brings out the fact that, so far as seasonal changes are concerned, high water and low water at Fort Hamilton are lowest in the winter months with a minimum about the latter part of January, and are highest in the summer months with a maximum in the early part of August. Sea level at Fort Hamilton therefore goes through the same annual change, the difference in the average height of sea level as between the latter part of January and the early part of August being seven-tenths of a foot.

The monthly variations in the heights of the tide noted above are average variations; obviously the variations produced by any individual storm or freshet would be considerably greater. On December 7, 1914, a northeast gale that had been blowing for almost two days, with a velocity at times exceeding 60 miles an hour, brought about a tide which at high water stood 5.1 feet above mean sea level—almost 3 feet above mean high water.

The highest tide recorded at Fort Hamilton since 1893 was 6.1 feet above mean sea level. This occurred on April 11, 1918. The lowest tide observed at Fort Hamilton since 1893 occurred on February 2, 1908, when low water fell 6.5 feet below mean sea level, or 4.1 feet below mean low water. The extreme range, therefore, as between the highest and lowest tides observed at Fort Hamilton is 12.6 feet. Compared with the average range of 4.7 feet this extreme range is 170 per cent greater.

The characteristics of the tide at Fort Hamilton prove it to be very nearly the tide of the open coast. Thus, as compared with the tide at Atlantic City where an automatic tide gauge has been in operation for a number of years on the Million Dollar Pier, we find the tide at Fort Hamilton to be some 15 per cent greater in range, with higher water occurring 27 minutes later and low water 38 minutes later. At Atlantic City, too, the seasonal changes in the height of the tide are similar to those found at Fort Hamilton, sea level being lowest about the latter part of January and highest in August, the difference being five-tenths of a foot. A notable difference, however, between the tide at the two places is found in the relative periods of rise and fall. At Atlantic City the two periods are equal, both rise and fall occupying a period of 6 hours 12 minutes; but at Fort Hamilton, the period of fall is 21 minutes greater than the rise, this increase in period of fall giving evidence of the existence of features characteristic of river tides.

Currents in the Narrows

In the rising and falling of the tide in New York Harbor a very considerable mass of water passes through the Narrows—from the sea into the harbor on the flood and from the harbor into the sea on the ebb. This movement of the water in and out through the Narrows gives rise to tidal currents. The characteristics of these currents are shown in Figure 5, in which the upper curves represent in graphic form the velocities of the current expressed in knots or geographic miles per hour, as observed in the center of the channel off Fort Wadsworth on August 17, 1922. The velocities of the current are shown for three depths, 17 feet, 44 feet, and 70 feet, these depths being respectively two-tenths from the surface, five-tenths, and eight-tenths from the surface. The curves above the zero line of velocities represent the northerly or flood current, and the curves below the zero line represent the southerly or ebb current. For comparison there is also shown the curve of the tide at Fort Hamilton on the same date.

It is to be noted that the current curves reproduce the general features of the tide curve. For the Narrows a comparison of the simultaneous tide and current curves shows that the slack of the current comes about midway between the times of high and low water; maximum flood current, or "strength of flood," occurs near the time of high water; and strength of ebb occurs about the time of low water. These time relations between current and tide are characteristic of the progressive-wave type of tidal

movement,[3] and we may therefore conclude that the tide in the Narrows is of the progressive-wave type.

An inspection of the current curves in Figure 5 brings to light the fact that the whole mass of water, from top to bottom, takes part in the tidal movement in and out through the Narrows. In two respects, however, the current curves for the different depths show unmistakable differences: the velocity of the current at the three depths is not the same, and the turn from flood to ebb (and vice versa) takes place at different times. These differences are due primarily to the fresh water discharged into the sea through the Narrows.

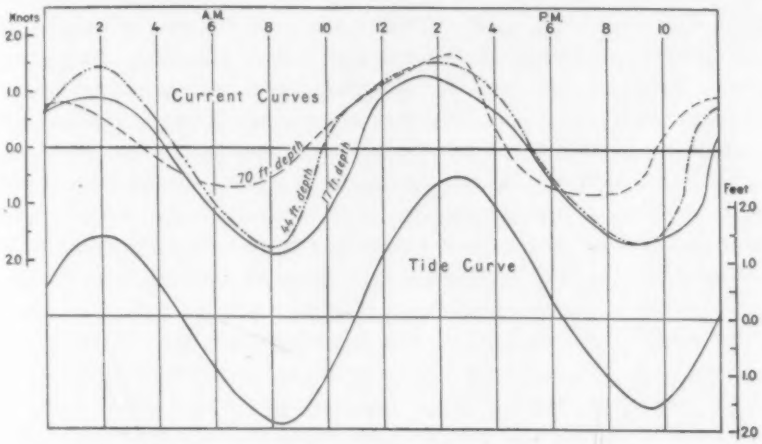

FIG. 5—Tide and current curves, the Narrows, New York Harbor, Aug. 17, 1922.

The streams tributary to New York Harbor bring to it at all times a very considerable amount of fresh water. During the months of March and April, when freshet conditions prevail, somewhat more than 50,000 cubic feet of this fresh or nontidal water is brought down every second to the Narrows to be discharged into the sea. And even during the month of August when the fresh-water run-off generally reaches its minimum, the fresh-water discharge through the Narrows is more than 13,000 cubic feet per second.[4]

Obviously the effect of this fresh water running continually toward the sea is to increase the duration and velocity of the ebb or outgoing current and to decrease the duration and velocity of the flood or incoming current. The 17-foot curve in Figure 5 brings this out clearly. But it is to be noted that the density of this fresh water is less than that of the saline water coming into the harbor from the sea. As a result the fresh water tends to keep toward the surface so that the effect mentioned should decrease from the surface downward. The 44-foot and 70-foot curves show this to be the

[3] H. A. Marmer: Tides in the Bay of Fundy, *Geogr. Rev.*, Vol. 12, 1922, pp. 195–205; reference on p. 202.
[4] *Rept. Metropolitan Sewerage Commission of New York, April 30, 1914*, p. 558.

case, the latter, indeed, indicating the greater duration and velocity for the flood current.

Since the current does not turn flood or ebb at the same instant from the surface to the bottom, it is evident that there will be times when the current near the bottom will be flowing in a direction opposite to the current near the surface. Thus from Figure 5 it is seen that at 10 A.M. on August 17, 1922, the current at the 17-foot depth was setting ebb, or southerly, with a velocity of about 1¼ knots, while at the same time the current at the 70-foot depth was setting flood, or northerly, with a velocity of ½ knot. It is to be observed, however, that at the time of strength the current from top to bottom is flowing in the same direction.

From day to day the tidal current undergoes changes which are related to the changes exhibited by the rise and fall of the tide. Full moon and new moon bring not only greater tides than usual but also stronger currents; likewise perigean tides mean stronger currents, while neap tides and apogean tides are accompanied by relatively weaker currents. In fact, from theoretical considerations the tidal current in the Narrows should vary in velocity as the tide varies in range, and this is borne out by the observations.

One other feature of the tidal movement in the Narrows should be mentioned, and that is the relation of the rising and falling tides to the flood and ebb currents. Figure 5 shows that from 2 A.M. to 8:20 A.M. the tide in the Narrows was falling; part of this time, however, the current was flooding—from 2 A.M. to 4 A.M.—and the rest of the time the current was ebbing. Similarly, from low water at 8:20 A.M. to high water at 2:30 P.M. the tide was rising; but during this period the current was ebbing part of the time and flooding the remainder of the time. And this state of affairs is characteristic of the tidal movement in the Narrows. On the first half of the rise the current is ebbing, on the second half it is flooding; on the first half of the fall the current is still flooding, but during the second half of the fall the current has turned ebb. The confusion that arises from identifying the rising tide with the flood current and the falling tide with the ebb current is clearly brought out by Figure 5.

Tidal Conditions in Upper Bay

The tide coming in through the Narrows progresses into Upper Bay at a rate dependent on the depth of the waterway, the rate of advance being given approximately by the formula $r = \sqrt{gd}$ in which r is the rate of advance, g the acceleration of gravity, and d the depth of water. At St. George, near the entrance to Kill van Kull, the tide is 20 minutes later than at Fort Hamilton; at Governors Island, at the mouth of East River, the tide is 25 minutes later; and in the entrance to Hudson River, abreast of Battery Place, it is 30 minutes later. Throughout Upper Bay the range of the tide is about 4.4 feet, or three-tenths of a foot less than in the Narrows. This decrease is not surprising in view of the considerable increase in the width of the tidal waterway north of the Narrows.

In its relation to the varying positions of sun and moon, and in its characteristics generally, the tide in Upper Bay is very much like the tide in the Narrows. The currents likewise reproduce the features of the current in the Narrows and, like the tides, are later in Upper Bay. The velocities of the current, however, are generally less than in the Narrows, corresponding to the decrease in the range of the tide.

Tidal Régime in the Lower Hudson

Past the Battery the tide from Upper Bay swings into the Hudson, and for a distance of 131 geographic miles, up to the state dam at Troy, the river carries the impulse of the tide. As it goes up the Hudson the tide acquires more and more the characteristics of river tides—the period of rise decreasing and the period of fall increasing—until at Troy the average period of rise is less than 5 hours, while the period of fall is increased to more than 7½ hours.

In ascending the river the time of tide becomes later, the distance to Troy being traversed in about 11 hours. This gives the tide a rate of advance of almost exactly 12 geographic miles per hour. In round numbers the average depth of the Hudson from its mouth to the head of tide water may be taken as about 20 feet. If in the formula for the rate of advance of a progressive wave, $r=\sqrt{gd}$, we substitute for d the value above, and for g 32.16 feet per second (this being the value of g for the latitudes of the Hudson), we get for r, the rate of advance, 25 feet per second, or 15 geographic miles per hour. Comparing this value with the actual rate of 12 miles per hour, we may conclude that the tide in the Hudson is primarily of the progressive-wave type.

At the mouth of the Hudson, abreast of Battery Place, the tide has a mean range of 4.4 feet. Going up the river the range decreases more or less regularly to West Point—a distance of 45 miles—where it averages 2.6 feet. The range then increases for a distance of a little more than 50 miles, attaining at Catskill a value of 4.1 feet. For the remaining distance of 35 miles the range again decreases, and at Troy it averages a little less than 3 feet.

In the upper Hudson both time and range of tide are very greatly affected by the amount of fresh-water run-off, and during the periods of heavy freshets the rise and fall of the tide is almost completely obliterated. In the lower Hudson, however, the effects of freshets are not so great; and in the stretch from the Battery to Spuyten Duyvil, the entrance to the Harlem, the tide is very much like that at Fort Hamilton. As regards time, the tide at Spuyten Duyvil is almost exactly 1½ hours later than at Fort Hamilton, and the mean range is 3.8 feet—decreasing gradually from 4.4 feet at the Battery. But, apart from these differences in time and range, the tide in the lower Hudson exhibits the features that characterize the tide at Fort Hamilton, and the tide curves shown in Figure 3 may be taken as typifying the tide in the river as far as the entrance to the Harlem.

The current phenomena in the lower Hudson, like the tidal phenomena, are similar to those in the Narrows. At the surface the ebb current has the greater velocity, but near the bottom the flood current is the greater. Throughout this stretch the velocity of the current at time of strength is approximately two knots at the surface and one knot near the bottom; strength of flood and ebb come respectively about the times of local high and low water, and slack current occurs midway between high water and low water. Figure 5, depicting the currents in the Narrows, may be taken as representative also of the currents in the lower Hudson.

From the Narrows, therefore, through Upper Bay and the lower Hudson, the tidal phenomena are very much the same, and likewise the current phenomena. Throughout this stretch the tidal movement is of the progressive-wave type; and this conditions the characteristics of both tides and currents, except as they are modified by the large amount of fresh water discharged through the Hudson.

Tides and Tidal Currents at the Eastern Gateway

The ocean tide that makes for New York Harbor from the east must traverse the waters of Long Island Sound before passing the eastern gateway to the harbor at Throgs Neck and entering East River. From the ocean the tide enters Long Island Sound through the Race where the average rise and fall is 2½ feet, high water and low water occurring about 1¾ hours later than at Fort Hamilton. Over the greater part of Long Island Sound the tidal movement is of the stationary-wave type, and it therefore follows that the times of high and low water change but little from one end to the other and that the range of the tide increases from the ocean entrance to the head of the Sound.[5]

At Throgs Neck the tide has a mean range of 7.2 feet, high water and low water occurring about 3¾ hours later than at Fort Hamilton. The tide curve representing the average rise and fall is shown in Figure 6, with reference to the time of the moon's passage over the meridian of Fort Hamilton. Throughout this paper the time of tide, when referred to the apparent revolution of the moon, will be taken with reference to the meridian of Fort Hamilton, since this procedure will make the time of tide at all places in New York Harbor directly comparable.

Comparing Figure 6 with the upper curve of Figure 3, which represents the mean curve of the tide at Fort Hamilton, it is seen at once that, apart from the difference in time and range, the tide curves for the two places exhibit differences in the character of the rise and fall. At Fort Hamilton the curve of the tide from high water to low water, and likewise from low water to high water, approximates closely to the cosine curve. At Throgs Neck, however, the rise and fall deviates from the cosine curve in that the tide curve is more rounded near the times of high and low water, giving a longer "stand" to the tide at those times.

[5] Marmer, *op. cit.*, pp. 202-203.

At Fort Hamilton Figure 3 shows that for a period of two hours—from one hour preceding to one hour following high or low water—the tide changes about 0.35 foot. Expressing this as a percentage of the total rise or fall, we have the result that the tide at Fort Hamilton changes 7½ per cent of its range in the two-hour period that includes high or low water. At Throgs Neck a like change of 7½ per cent of the range covers a period of three hours. As a consequence of the relatively long stand of the tide at high and low water, the tide at Throgs Neck changes very rapidly about the time of mean sea level. For the period of two hours that extends one hour each side of mean sea level the tide changes in height 4½ feet, or more than 60 per cent of the total rise and fall.

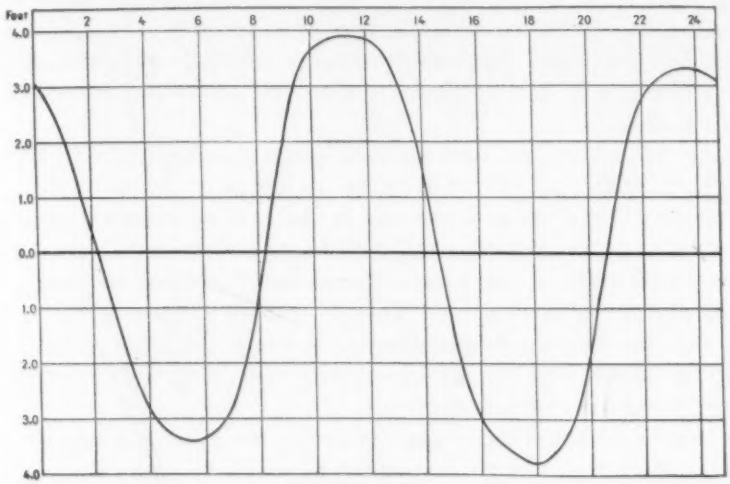

FIG. 6—Curve of the tide at Throgs Neck, at the eastern entrance to East River.

With regard to the changes in the rise and fall in response to the changing positions of the moon relative to earth and sun, the tide at Throgs Neck behaves much like that at Fort Hamilton. Spring tides are 19 per cent greater than the average, the range then being 8.5 feet, and neap tides are 21 per cent less than the average, having a range of 5.7 feet. Perigean tides bring ranges of 8.2 feet—15 per cent above mean range—and apogean tides bring ranges of 6.4 feet, or 11 per cent below the average. The tide at Throgs Neck shows somewhat more diurnal inequality in the low waters—0.4 foot for the average tide and 0.6 foot for the tropic tide—but in the high waters the inequality is very much like that at Fort Hamilton, being 0.6 foot on the average and 1 foot at the time of tropic tides.

The seasonal changes in the height of the tide at Throgs Neck are not so well determined as at Fort Hamilton, the observations extending over a shorter period. However, from the harmonic analysis of a series of tidal observations at Willets Point extending over a period of two years, it appears that in the eastern entrance to East River the tide is highest early in July

and lowest early in January with a range of 0.3 foot, or about half the corresponding range at Fort Hamilton.

The currents in the channel abreast of Throgs Neck are much weaker than the currents off Fort Hamilton. Instead of velocities up to two knots, the currents here have velocities which, at strength, are barely over one knot. The characteristics of the tidal currents in the eastern gateway and the time relations of these currents to the tide are shown in Figure 7, which is a plotting of the observations made in the center of the channel between Throgs Neck and Willets Point on August 6, 1922. The current velocities at three depths are shown—at 22 feet, 55 feet, and 88 feet. These depths represent respectively distances from the surface two-tenths, five-tenths, and eight-tenths of the depth at that point. The curves above the zero line of velocities represent the westerly flowing current, and the curves below the zero line represent the easterly flowing current. For comparison the curve of the tide at Throgs Neck on the same day is plotted in the lower part of the diagram.

Exactly the same time and velocity scales are used in Figure 7 as in Figure 5. A glance at the two figures shows that, despite the fact of a considerably greater range of the tide in the eastern gateway, the currents here have a velocity approximately half that at Fort Hamilton. Attention is called to this fact to emphasize the necessity of distinguishing between tide and current at any place. To say that at a given point there is a "strong tide" is not very enlightening, for what is probably meant by such a statement is not that the tide has a relatively large range but that the current has considerable velocity.

Now it is to be noted that, while at any given point the velocity of the current changes from day to day as the range of the tide changes, it does not at all follow that as between two places having different ranges of tide the larger range is accompanied by the stronger current. Fort Hamilton and Throgs Neck furnish one example in illustration of this; but a still better one is furnished by a comparison of the tides and currents at the two ends of Long Island Sound. In the Race, the entrance from the ocean to Long Island Sound, the tide has a range of 2.5 feet but is accompanied by a current of 3.5 knots or more; at Throgs Neck the range of tide is 7.2 feet, while the velocity of the current is barely one knot.

Two factors determine the velocity of the current in coastal or inland tidal waters at any point along the channel. The first is the volume of water that must flow through the channel past the point, and the second is the area of the cross section of the channel at that point. It is the latter factor that generally makes the current, more than the tide, immediately responsive to changes in geographic or hydrographic features. A change in the cross-sectional area of a tidal waterway produces a change in the velocity of the current, even though the range of the tide be not perceptibly changed.

One of the characteristic features of the stationary-wave type of tidal movement is that the slack of the current comes at the times of high and

low water, while the strength of the current comes midway between high and low water.[6] Figure 7 brings out the fact that off Throgs Neck the slack of the current comes, approximately, midway between high and low water and the strength of the current about the times of high and low water. In this respect the current here resembles the current off Fort Hamilton, where the tidal movement is of the progressive-wave type. In the channel off Throgs Neck, therefore, the time relations of current and tide have been very considerably modified from those prevailing over the greater part of Long Island Sound. Here it will be sufficient to note merely that this change

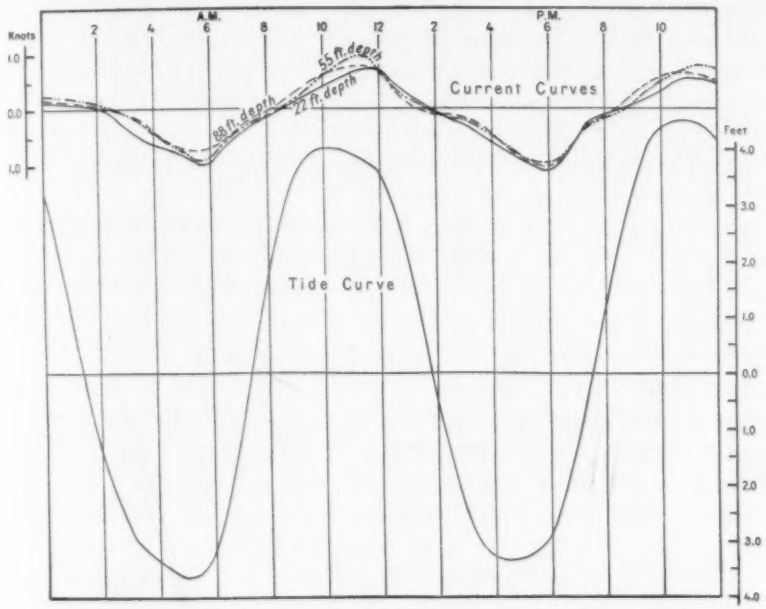

FIG. 7—Tide and current curves off Throgs Neck, East River, New York, Aug. 6, 1922.

is brought about by the transition from the stationary-wave movement in Long Island Sound to the type of tidal movement that prevails in East River.

Past Throgs Neck the Long Island Sound tide enters East River at its eastern end. About fourteen miles southwesterly the ocean tide that has come in through the Narrows passes Governors Island and enters East River at its western end. The tides at Throgs Neck differ considerably from those at Governors Island in time, range, and characteristics of rise and fall. These differences give rise to tidal phenomena in East River which at first glance appear perplexingly involved; but before discussing these phenomena it will be of advantage to consider somewhat more fully four matters relating to tides and currents which are of particular significance

[6] Marmer, *op. cit.*, p. 202.

in the tidal movement of the water in East River. These matters are: the velocity of tidal currents and the rate of advance of the tide; the distance traveled by a particle during a tidal cycle; the direction of flood in a strait; and the duration of slack water.

Velocity of Tidal Currents and Rate of Advance of the Tide

In the movement of water brought about by the tide, it is important to distinguish clearly between the velocity of the current and the rate of advance of the tide. In the former case we are dealing with the actual speed of a moving particle while in the latter we are dealing with the velocity of propagation of wave motion, which generally is many times greater than the velocity of the current. Thus in the lower Hudson the currents have a velocity of about 2 knots at time of strength. But the rate of advance of the tide in the Hudson was found to be about 12 miles per hour, or six times as great as the velocity of the current.

Now it is to be noted that there is no necessary relationship between the velocity of the tidal current and the rate of advance of the tide; in other words, if the rate of advance of the tide at any place is given we cannot from that alone infer the velocity of the current at that place nor vice versa. The rate of advance of the tide depends on the type of tidal movement. In a progressive wave the tide moves in accordance with the formula $r=\sqrt{gd}$. In stationary-wave movement, since high water or low water occur at very nearly the same time over a considerable area, the rate of advance is theoretically very great; but actually there is always some progression present, and this reduces the theoretical velocity considerably.

The velocity of the tidal current at any point, or the actual speed with which the particles of water are moving, depends on the volume of water that must pass the given point and the cross section of the channel at that point. The velocity of the current is thus independent of the rate of advance of the tide.

Distance Traveled by a Particle During a Tidal Cycle

If the velocity of the current during a tidal cycle were constant, the distance traveled by the water particles or by any object floating in the water would be given by multiplying the velocity by the time. The velocity of the current, however, is not constant but changes continually throughout the tidal cycle. The distance traveled by the water particles is therefore the average velocity during any interval multiplied by the time.

The average velocity of the current during any given interval may be determined in a number of ways. By measuring the velocity on the current curve at frequent intervals—say every 10 or 15 minutes—the average velocity is easily derived. Or we may determine the area of the surface

bounded by the current curve and the zero line of velocities, by means of a planimeter, and derive the average velocity by dividing this area by the length of the zero line included within the current curve.

Much the simplest method, however, consists in making use of the well-known ratio of the mean ordinate of the cosine curve to the maximum ordinate, which is $2 \div \pi$, or 0.637. Since the velocity of a tidal current is almost invariably specified by its velocity at time of strength—which corresponds to the maximum ordinate of the cosine curve—the average current, by this method, is given immediately by multiplying the strength of the current by 0.637. It is to be noted, however, that this method is only approximate, since the curve of the current may deviate more or less from the cosine curve; but for all practical purposes the results will be sufficiently accurate.

Applying the above rule in the case of a current having a velocity of 2 knots at time of strength, a floating object will be carried, during a flood or ebb period of 6.2 hours, a distance of $0.637 \times 2 \times 6.2$ geographic miles, or 48,000 feet. It may be of interest to note here that for the Hudson River and Upper Bay the distance traveled by a floating object, calculated as above, was found to agree closely with that actually traversed by a float.[7]

What Is Flood in a Strait?

As ordinarily understood, the flood current is the one that sets inland or upstream, and the ebb current the one that sets seaward or downstream. This usage leads to no confusion in the case of bays and rivers, since there can generally be no question as to which direction is upstream and which downstream. But in the case of a strait which connects two bodies of water each of which has an independent passageway to the sea the terms upstream and downstream no longer have precise meanings.

East River furnishes a case in point. Parenthetically it may here be remarked that the term river applied to this waterway is a misnomer, for East River, so called, is a strait connecting Upper Bay and Long Island Sound. The mariner entering East River from the east may, not inconsistently, claim that he is going inland or upstream, and hence the current setting into East River past Throgs Neck—the westerly-setting current—would by him be called the flood current. But a fellow-mariner entering East River from the west—past Governors Island—can with as much show of consistency claim to be going upstream and thus call the easterly-setting current flood. What is the way out of this dilemma?

The tidal mathematician here comes to our rescue. Instead of speaking of flood and ebb in a strait in terms of upstream and downstream, he makes use of the time relations of current and tide. Flood he defines as the current which attains its maximum velocity or strength on a rising tide, and ebb

[7] H. de B. Parsons: Tidal Phenomena in the Harbor of New York, *Trans. Amer. Soc. of Civil Engineers*, Vol. 76, 1913, pp. 1979–2106 (discussion, pp. 2094–2106); reference on p. 2028.

the current which attains its strength on a falling tide.[8] This gives a simple and at the same time a rigorous criterion for determining in all cases which current is to be called flood and which ebb. Furthermore, this definition of flood and ebb gives to the currents in tidal bays and rivers the same designation as does the definition based on the notions upstream and downstream.

Duration of Slack Water

Where the current at time of strength attains a velocity of two knots or more, it becomes a matter with which the navigator must reckon; and where a velocity of five knots or more exists, as for example in Hell Gate, East River, it may become necessary for the navigator to await the time of slack water before attempting to make the passage. The question is therefore frequently raised, How long does slack water last?

To this seemingly simple question no direct answer can be given, for it all depends on just what is meant by the term slack water. A glance at Figures 5 and 7 shows that the time during which the current has no movement is but a moment—the instant when the current curve cuts the zero line of velocities—and hence when the tidal mathematician speaks of slack water he has in mind that mathematical instant. Apart from the mathematician, however, slack water is thought of as a period of time extending over a number of minutes during which the current is at a standstill, neither flooding nor ebbing. And the layman is at a loss to understand why no direct answer is given to his simple question, How long does slack last?

Now if we consider the period of slack water to be the interval of time during which the velocity of the current is so small that for *practical purposes* it may be disregarded, we make the term connote the meaning attached to it in ordinary usage. Current velocities less than one-tenth of a knot may for all practical purposes be disregarded; and, furthermore, such velocities are difficult to measure either with float or with current meter. We may therefore give the term slack water a definite meaning in ordinary usage by defining it to be the period during which the velocity of the current is less than one-tenth of a knot.

Setting one-tenth of a knot as the limit of slack water is, to be sure, somewhat arbitrary. But for the reasons noted above this limit appears better than one greater or less. And slack water so defined now permits us to answer the question, How long does slack water last? For all that need be done is to measure, on the current curve for any given place, the interval during which the velocity of the current is less than one-tenth of a knot. For example, from the current curves in Figure 5 we find that in the Narrows, at a depth of 17 feet, slack water lasts about 10 minutes.

It is obvious that with strong currents the duration of slack water is relatively short while with weak currents it is greater. In fact, where the

[8] R. A. Harris: Manual of Tides, Part V: Currents, Shallow-Water Tides, Meteorological Tides, and Miscellaneous Matters, *U. S. Coast and Geodetic Survey Rept. for the Year Ending June 30, 1907*, Washington, D. C., 1907, pp. 231–545 (=Appendix 6); reference on p. 338.

current curve does not deviate very much from the cosine curve the duration of slack water is a function of the strength of the current. Regarding the current curve as approximately a cosine curve, we may compute the duration of slack water directly from the equation of the cosine curve; for if we write this equation in the form $y = A \sin 0.483t$ in which A is the velocity of the current at time of strength, 0.483 the number of degrees per minute in a tidal period of 6.2 hours and t the time in minutes from the moment of zero velocity, we have for deriving the duration of slack water the equation $0.1 = A \sin 0.483t$. It is to be noted that the value of t derived from the above equation gives one-half the duration of slack water, the total period of slack being $2t$.

Based on the above equation the following values for the duration of slack water have been computed. With currents which at strength have a velocity of one knot the duration of slack water, that is the period during which the velocity of the current is less than one-tenth of a knot, is 24 minutes; with currents of two knots strength, 12 minutes; three knots, 8 minutes; four knots, 6 minutes; five knots, 5 minutes.

The Tide in East River

From Upper Bay, past the Battery, East River carries the tide northeastward while the Hudson River carries it northward. The average depth of East River is approximately the same as that of the lower Hudson from the mouth to Spuyten Duyvil, being in both cases approximately 30 feet.[9] The distances too are very nearly the same, the channel of East River from the Battery to Throgs Neck measuring fourteen geographic miles, while that of the Hudson River up to Spuyten Duyvil measures twelve miles. The tide, however, takes but an hour to traverse the twelve miles up the Hudson, while in the fourteen miles of East River there is a change of 3¼ hours in the time of tide.

It is to be noted, too, that in the Hudson the time of the tide changes in a uniform manner from the Battery to Spuyten Duyvil, each mile being traversed in approximately five minutes. In East River this is not the case. In the first six miles—from the Battery to the northern end of Blackwells Island—the tide becomes later by two hours, the change taking place in a relatively uniform manner; that is for each mile there is a change of about 20 minutes in time of tide. From the end of Blackwells Island through Hell Gate the time of tide changes very rapidly, this stretch of a mile and a half showing a change of 1½ hours, or a change at the rate of 60 minutes for each mile. For the next three miles there is practically no change in the time of tide, and for the remaining three and a half miles to Throgs Neck there is a change in the opposite direction, the tide actually becoming earlier by a quarter of an hour.

Not only in time but also in range of tide do the two waterways exhibit

[9] *Rept. Metropolitan Sewerage Commission of New York, April 30, 1914*, p. 548.

marked differences. From a range of 4.4 feet at the Battery the tide in the Hudson decreases to 3.8 feet at Spuyten Duyvil, this decrease of 13½ per cent in the range taking place in a uniform manner throughout the stretch of twelve miles, or at the rate of a little over one per cent per mile. In East River, from the range of 4.4 feet at the Battery the tide increases to a range of 7.2 feet at Throgs Neck—an increase of 63½ per cent—but this increase is not uniform over the stretch of fourteen miles.

For the first three miles from the Battery the tide, instead of increasing, actually decreases almost one-half of a foot, the rise and fall of the tide

FIG. 8—East River and portions of the Hudson and Harlem Rivers. Reduced from *U. S. Coast and Geodetic Survey Chart No. 1213.*

a little north of the Navy Yard being exactly 4 feet. After this initial decrease the tide begins to increase in range, mounting steadily each mile until at Throgs Neck 7.2 feet is attained. In the first three miles, therefore, the tide in East River decreases at the rate of 3 per cent per mile, while for the remaining eleven miles there is an increase in the range at the rate of 7¼ per cent per mile.

Now it is important to note that this behavior of the tide in East River, so strikingly different in regard to both time and range from the tide in the waters around it, cannot be ascribed to any peculiar hydrographic or geographic features of the waterway itself. As we shall see later in the discussion of the character of the tidal movement, the time and range of the

tide in East River are conditioned by the fact that East River is a short strait connecting two bodies of water having tides independent of each other.

As regards the characteristics of the rise and fall of the tide throughout East River, it may be said that from the Battery to Hell Gate the tidal curves are very much like those for Fort Hamilton shown in Figure 3, while in the stretch from Hell Gate to Throgs Neck the tide curves exhibit the more rounded appearance of the tide at Throgs Neck shown in Figure 6.

The Current in East River

From the Battery the current in the Hudson River, like the tide, becomes later in going upstream, so that at Spuyten Duyvil both strength and slack of the current come very nearly one hour later than at the Battery. In East River conditions are reversed, the slack and also the strength of current occurring earlier in going up the river from the Battery, the time of the current at Throgs Neck being almost exactly one hour earlier than at the Battery.

It is to be recalled that the time of *tide* becomes later from the Battery to Throgs Neck by 3¼ hours. Since the time of current in the same stretch becomes earlier, it is obvious that the relation of the time of current to the time of tide varies considerably from one end of the river to the other. At its western end, off the Battery, the current that sets into East River—the easterly-flowing current—attains its strength about 4½ hours after local low water. Abreast of Throgs Neck, at the eastern end of the river, this same current attains its strength about half an hour after low water.

The easterly-setting current, therefore, throughout the whole extent of the East River, attains its strength between the times of low water and high water. Since by definition the flood current is the one that attains its strength on a rising tide, the flood current in the East River is the easterly-flowing current, the one that sets from Upper Bay into Long Island Sound. The westerly-flowing current, that sets from Long Island Sound into Upper Bay, is therefore the ebb current. In this connection it may be of interest to note that these designations, which follow from the tidal mathematician's definition, are also the ones that have been applied to the easterly and westerly currents of the East River by the pilots.[10]

The swiftest currents found in New York Harbor occur in East River. The average velocity at time of strength throughout the stretch from Governors Island to Throgs Neck is about 2½ knots, but this velocity varies from place to place in accordance with the variation in cross section of the waterway. In Hell Gate and in the channel to the west of Blackwells Island the area of the cross section is greatly reduced, and here velocities of five knots and more are of frequent occurrence.

As regards the characteristics of the currents, East River may be considered as consisting of two parts, with Hell Gate as the connecting link.

[10] *U. S. Coast Survey Rept. for the Year 1867*, Washington, D. C., 1869, p. 161.

In the lower part—from the Battery to Hell Gate—the westerly, or ebb, current has the greater velocity. In the upper part—from Hell Gate to Throgs Neck—it is the flood, or easterly, current that has the greater velocity. Furthermore, in lower East River the currents exhibit practically no effects of fresh or non-tidal water, while in upper East River the effects of fresh water are distinctly evident but only in the easterly-flowing current.

Character of Tidal Movement in East River

In the discussion of tidal phenomena it is frequently of advantage to employ terms that relate to wave motion. Thus we speak of the advance of the *tide wave*, of high water as the crest of the tide wave, and of low water as the trough; the two principal types of tidal movement are designated as the progressive-wave and stationary-wave types. In terms of wave motion, therefore, the tidal movement in the East River is frequently described as resulting from the "interference of the two tidal waves, the one entering from Upper Bay and the other from Long Island Sound."

Notwithstanding the advantages accruing from the conception of the tide in terms of wave motion, its application to the tidal movement in the East River is unfortunate. To ascribe the tidal and current phenomena in this waterway to the "interference of tide waves" relegates the whole matter to the mathematician and enshrouds the mechanism of the movement, which in reality is quite simple, with a terminology which makes it inexplicable in non-mathematical language. Moreover, it frequently leads to absurd statements; as for example, that "the two tide waves, entering East River from Upper Bay and from Long Island Sound, meet in a high water crest somewhere east of Whitestone Point."

The movement of the water in East River is brought about by the fact that part of the time the level of the water in Upper Bay is higher than in Long Island Sound and part of the time it is lower. East River thus acts merely as a channel through which the water flows from the body having, temporarily, the higher level to the one having the lower level. In other words, the movement of the water in East River is primarily hydraulic in character.

From simple hydraulic considerations it is evident that when the level of the water at the two ends of East River is the same no movement of the water can take place; but as soon as a difference in level arises, the water will flow towards the body having the lower level. Furthermore, the velocity of this current increases as the difference in level increases, the maximum velocity or strength of current coming at the time of greatest difference in level. Hence, if we plot the heights of the tide at the two ends of East River, the lines joining simultaneous heights will indicate by their slope the difference in level; and, if the reasoning above applies, we should expect slack water about the time of zero slope and strength of current about the time of maximum slope.

In Figure 9 the simultaneous heights of the level of the water at the two ends of East River are represented for each hour of the tidal rise and fall, time being reckoned from the instant of the moon's passage over the meridian of Fort Hamilton. On the vertical line to the left the hourly height of the tide is plotted as taken from the mean tide curve for the Battery, while on the vertical line to the right the hourly heights are taken from the mean tide curve for Throgs Neck. In both cases the heights are measured from mean sea level, indicated by the heavy horizontal line, the scale of heights in feet being shown to the left. The figures along the vertical lines denote the hours to which the indicated heights apply, the hours and heights being placed to the left of each vertical line for the rising tide and to the right

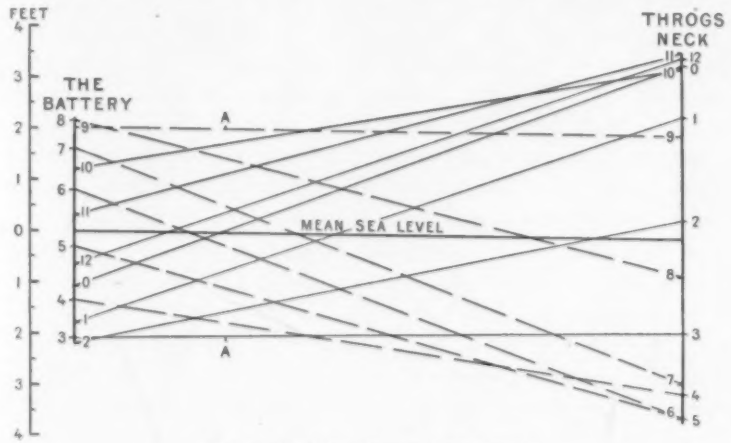

FIG. 9—Slope-line diagram, East River.

for the falling tide. The slope lines—the lines joining simultaneous heights—are drawn full when the slope is from Long Island Sound to Upper Bay, and dashed when the slope is in the reverse direction.

If the movement of the water in East River is due to the difference of level at the two ends, as pictured in Figure 9, then high water at any given place in the river is the highest point in the slope lines passing that place, and low water is the lowest point in the slope lines. Furthermore, the times of high and low water at that place are given immediately by the respective slope lines on which the highest and lowest points are found. For example, at A, one fourth the distance between the Battery and Throgs Neck, the highest point is on the 9-hour slope line, and the lowest point is on the 3-hour line. On the scale in feet to the left these points are respectively 2 feet above and 2 feet below mean sea level. Hence the height to which high water at point A rises is 2 feet above sea level, and the depth to which low water falls is 2 feet below sea level, giving a range at that place of 4 feet—less, be it noted, than the range at the Battery. The time of high water at A, with respect to the moon's passage over the meridian of Fort Hamilton, is obviously 9 o'clock and the time of low water 3 o'clock.

From the diagram it is evident that the highest points of the slope lines define the curve of the high waters in the river, while the lowest points define the curve of the low waters. The diagram, therefore, shows at once that from the Battery the range of the tide decreases for about one-quarter the way to Throgs Neck, after which it increases. And this, it is to be recalled, we found to be the case. Furthermore, the diagram gives the smallest range in the river as 4 feet, which figure is exactly that found by actual observation. This decrease of the range in the first three miles of East River—which upon being shown by observation to exist has generally been ascribed, in a vague way, however, to the "interference of tide waves"—is thus shown to follow immediately by considering the movement of the water to be hydraulic.

One other feature of the tides in East River merits more than passing mention because of its practical importance, and that is the line of low water in the river. This line, instead of being a straight line between the Battery and Throgs Neck, as might be expected at first thought, is shown by the hydraulic diagram of Figure 9 to be a curved line convex toward the surface. This is characteristic of the low water line in a waterway which connects two independent tidal bodies of water, and its practical importance lies in the fact that in the deepening of such a waterway a considerable saving in excavation may frequently be made. For instead of dredging the bottom to a uniform depth below mean sea level, advantage may be taken of the fact that the low water line for some distance lies above the straight line joining the low water points at the two ends.

The current phenomena in East River likewise may be derived from the hydraulic diagram of Figure 9. Thus, the times of slack and of strength of the current should obviously be very nearly simultaneous throughout the river, the former occurring when the difference in level at the two ends is zero and the latter when the difference is greatest. From Figure 9 we find that, with reference to the time of the moon's passage over the meridian of Fort Hamilton, the water at both ends is at the same level a little after 3 o'clock and also at 9 o'clock. From observations it is found that the time of slack water changes but little throughout the river, the average time being a few minutes later than given by the diagram.

The greatest slope towards Upper Bay is shown by the 1-hour line, and hence the strength of the westerly current should come about 1 o'clock; the greatest slope towards Long Island Sound is shown by the 7-hour line and the strength of the easterly-flowing current should come about 7 o'clock. Observations show that these times are approximately the times of strength of the respective currents throughout the river.

It is obvious that the simple hydraulic considerations on which Figure 9 is based can give only a first approximation to the tidal and current conditions existing in East River. No account has been taken of the varying depths in the waterway, of the differences in width and changes in direction, nor of the effect of the water coming through Harlem River. The slope

lines are drawn as if the channel from the Battery to Throgs Neck ran straight for the stretch of fourteen miles with unvarying width and depth. However, notwithstanding the modifications that must arise from the fact that East River deviates from the uniform channel assumed in Figure 9, the principal tidal and current phenomena in the river are easily derived by considering the movement of the water in East River as hydraulic. The outstanding advantage of regarding the phenomena from the hydraulic point of view is that it permits us to visualize the mechanism of the movement of the water.

Tides and Currents in Harlem River

Harlem River is a strait, about six geographic miles in length, connecting the Hudson with East River. At Spuyten Duyvil, the entrance from the Hudson, the tide has a mean range of 3.8 feet and is 1½ hours later than at Fort Hamilton. At the East River end of the Harlem the tide has a range of about 5 feet and is 2½ hours later than at Fort Hamilton. The conditions in the Harlem are therefore similar to those in East River, the tides and currents being due to the difference in level of the water at the two ends.

It follows, therefore, at once that the time of the current throughout the Harlem will be practically the same. The current will be slack when the water at the two ends is at the same height, while it will be at its maximum velocity when the difference in the level of the water at the two ends is greatest. A slope line diagram, drawn as in Figure 9, will enable the times and ranges of the tide and also the time of strength and slack of the current to be determined. However, owing to the fact that the difference in time of tide at the two ends of the Harlem is but one hour while for the two ends of East River this difference is 3¼ hours, the slope lines for the strength of the current in the Harlem are not as steep as in East River, and hence the currents are not as strong.

The southerly-setting current—the one that carries the waters of the Hudson into East River—attains its strength about 2¾ hours before high water in the Harlem, that is while the tide is rising. Hence in the Harlem it is the southerly-setting current that is the flood current. The ebb current, flowing from East River toward the Hudson, attains its strength about 3½ hours before low water. Throughout the river the ebb current has a slightly greater velocity, the average velocity for the center of the channel being about 1¼ knots for the flood and about one-tenth of a knot more for the ebb. Under the bridges, however, where there is a constriction in the waterway, the velocity of the current exceeds two knots at strength.

Tides and Currents in Kill van Kull

The tidal and current phenomena in Kill van Kull are similar to those in the Harlem. For the Kill van Kull is a short strait—measuring three geographic miles in length—connecting Newark Bay with Upper Bay. On

the Newark Bay end the tide has a range of 4.7 feet and is about 40 minutes later than at Fort Hamilton. On the Upper Bay end the tide has a range of 4.4 feet and is 20 minutes later than at Fort Hamilton. This difference in the tides at the two ends of 20 minutes in time and 0.3 foot in range gives rise to tidal currents which in the center of the channel have a velocity of from 1 to 2 knots.

Since there is but 20 minutes difference in the time of tide at the two ends of the Kill, the time of tide as well as the time of current is practically simultaneous throughout the Kill. The flood current, as a slope-line diagram shows, is the westerly flowing current, and the ebb current is the easterly one. Strength of flood comes about 2 hours before the time of high water at Fort Hamilton, and strength of ebb comes about 2½ hours before low water; with respect to the time of local tide this is 2¼ hours before high water and 2¾ hours before low water.

Circulation of the Sea Through the Harbor

In consequence of the tide, there is a ceaseless interchange of water between the harbor and the sea. For a period of approximately six hours, on the flood, the sea pours its waters into the harbor, and in the following period of six hours the harbor waters move toward the sea.

The current does not turn to flood or ebb at the same time throughout the various parts of the harbor. It turns earliest in Kill van Kull and latest in the Hudson, but this difference is only three hours. For the remaining three hours of the flood or ebb cycles the current will be flooding or ebbing throughout the whole harbor. Figure 10 is a schematic representation of the current in the component parts of New York Harbor one hour before the time of high water at Fort Hamilton. At this time the current throughout the harbor is running flood at very nearly its strength. Through the Narrows the ocean waters are now pouring into Upper Bay with the greatest force, carrying into the harbor at this time about three-quarters of a million cubic feet each second; in Kill van Kull the strength of the current occurred one hour before; in East River the current is just about at its strength setting towards Long Island Sound; in the Harlem likewise the current is about at its strength, flowing into East River, while in the Hudson the current is gathering momentum for the strength which will occur about 1½ hours later.

Figure 11 represents the conditions six hours later, or one hour before the time of low water at Fort Hamilton. Throughout the harbor the current is running ebb at very nearly its strength. For 1½ hours the Hudson has been returning the tidal water received on the previous flood together with the fresh-water run-off from the thousands of miles of territory it drains; but the strength of the ebb in the Hudson is still 1½ hours away. The Harlem is now running at its strength carrying the waters of the Hudson toward East River, while in the latter the current is setting toward

Upper Bay, the strength of the current having occurred about half an hour previously. In Kill van Kull the strength of the ebb is 1½ hours past, but the waters of Newark Bay are still flowing into Upper Bay. Gathering the ebb waters from the Hudson River, East River, and Kill van Kull, Upper Bay pours them out to sea through the funnel of the Narrows, though it is to be noted that at this time—one hour before low water at Fort Hamilton—the current through the Narrows is still about an hour from its strength.

For the port of New York and for the communities situated along the

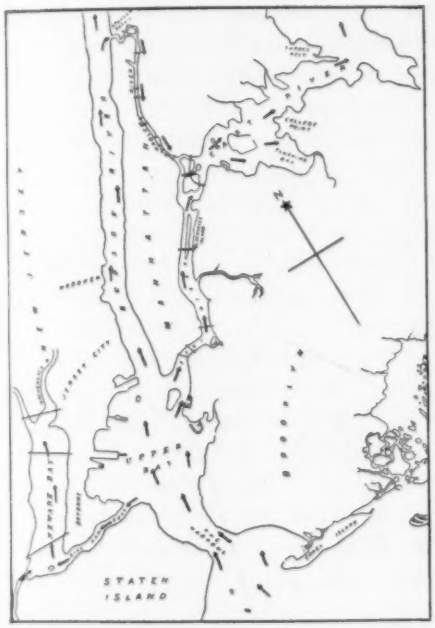

FIG. 10—Flood in New York Harbor.

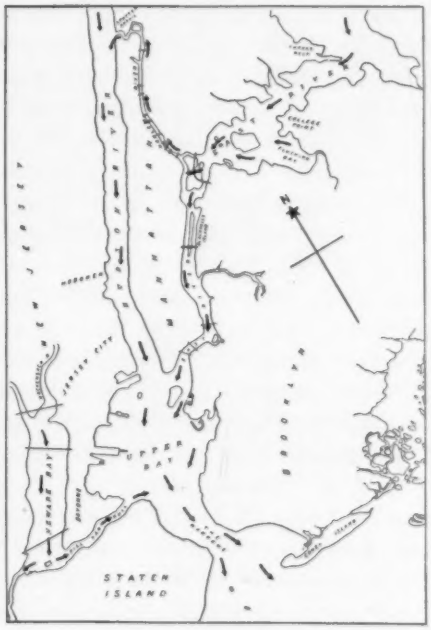

FIG. 11—Ebb in New York Harbor.

banks of the tidal streams tributary to the harbor this interchange of water consequent on the tide is of importance in connection with the maintenance of the channels and the disposal of sewage. In the maintenance of the channel of a waterway tidal currents are of importance, since sand will be moved along the bottom of the channel by a current of 2/5 of a knot, fine gravel by a current of 1 knot, shingle 1 inch in diameter by a current of 2½ knots, and angular stones 1½ inches in diameter by a current of 3½ knots.[11] In the disposal of sewage the tidal action is of a twofold character. In the first place, the tidal currents carry some of the solid and liquid ingredients out to sea; and, secondly, the uncontaminated sea water brought into the harbor on the flood aids in assimilating the sewage and thus converting it into inert mineral matter.

[11] Harris, *op. cit.*, p. 423.

The determination of the quantity of water passing in and out of New York Harbor past any given point is, in principle, a simple matter; for it is obviously equal to the product of four factors, namely, the width of the channel at that point, the average depth, the average velocity of the current, and the duration of flow. The first two factors can be determined very readily from any good chart of the harbor; the last one may be determined with reasonable precision from a series of current observations of moderate length; but the determination of the average velocity is, in a tidal waterway such as New York Harbor, a matter of very considerable difficulty. Without entering into the details of the difficulties involved, mention may be made of the following facts: the velocity of the tidal current at any point changes throughout the day, approximately in accordance with the cosine curve; from day to day the velocity changes as the range of the tide changes; at any point in a waterway the velocity of the current is not uniform from surface to bottom; and, finally, the velocity of the current in any horizontal section varies from the center of the channel to the banks.

The determination of the average velocity of the current corresponding to a mean tide is therefore far from being a simple matter. Furthermore, in a harbor where traffic is as dense as in New York Harbor, the making of current observations is in itself a problem of considerable magnitude. It is therefore not surprising that the values arrived at by different investigators vary somewhat. From observations made in 1885 Henry Mitchell, of the Coast and Geodetic Survey, estimated the volume of water passing through the Narrows as 12,703,616,481 cubic feet on the flood and 13,819,895,144 cubic feet on the ebb, or a net seaward discharge of somewhat more than 1,116,200,000 cubic feet each half day.[12] Based on observations made by the Metropolitan Sewerage Commission of New York between 1907 and 1909, Parsons estimated the flood and ebb volumes through the Narrows as 10,778,800,000 cubic feet and 12,041,200,000 cubic feet respectively, or a net seaward discharge of 1,262,400,000 cubic feet per tidal cycle.[13]

A more comprehensive series of current observations than either of the above investigators had at hand was made jointly by the Army Engineers and the Coast and Geodetic Survey in the summer of 1922. The computations have not yet been completed, but it appears that the above estimates are substantially correct and that in round numbers we may safely take the average volume passing the Narrows on the flood as 11 billion cubic feet per tidal cycle and on the ebb as 12¼ billion cubic feet. During each tidal cycle of 12½ hours there is therefore, on the average, a net seaward movement of 1¼ billion cubic feet through the Narrows, that is a movement at the rate of 2½ billion cubic feet per day. This excess of the ebb volume over the flood is obviously to be ascribed, if not wholly at least in very large part, to the run-off from the territory that drains into New York

[12] *U. S. Coast and Geodetic Survey Rept. for the Year Ending June, 1886*, Washington, D. C., 1887, p. 36.
[13] Parsons, *op. cit.*, p. 2037.

Harbor. Estimates of the amount of this fresh, or non-tidal, water, based on gaugings of the Mohawk and Hudson Rivers above Troy and on rainfall data for the territory below Troy, give 25,000 or 26,000 cubic feet as the average discharge per second past the Narrows,[14] or, in round numbers, a discharge of about 2¼ billion cubic feet per day.

From the Upper Bay the tide carries 5¾ billion cubic feet into the Hudson during the flood, while during the ebb the Hudson discharges into the bay 6¾ billion cubic feet, the fresh-water run-off being a little in excess of 1 billion cubic feet during a tidal cycle of 12½ hours,[15] or 2 billion cubic feet per day. Through Kill van Kull the flood carries from New York Harbor into Newark Bay 1½ billion cubic feet, and the ebb returns into the harbor very nearly 100 million cubic feet more;[16] so that in a day Newark Bay pays tribute of almost 200 million cubic feet of water to New York Harbor. For the Harlem River, Parsons calculated a net ebb or northerly discharge into the Hudson River of 17½ million cubic feet for a full tidal cycle, or about 35 million cubic feet per day. For the central portion of the Harlem his figures give a movement of about 162½ million cubic feet for the flood and 180 million cubic feet for the ebb.[17] A considerably larger figure for the ebb excess in the Harlem is derived by Robinson from later observations; he gives 44 million cubic feet[18] per tidal cycle as the excess of ebb over flood or nearly 90 million cubic feet per day.

The question of the net resultant discharge of East River has been the subject of considerable discussion. Attention was first directed to the matter by Henry Mitchell[19] who derived, from a short series of observations, a volume of 4455 million cubic feet for the ebb and 4007 million cubic feet for flood,[20] or a net resultant discharge from Long Island into New York Harbor of very nearly 900 million cubic feet per day. This excess of ebb over flood he attributed to the fact that in East River the depth of the water is greater when the current is flowing from Long Island Sound to Upper Bay than when the current is in the reverse direction. This fact is brought out in Figure 9, which shows that the westerly-slope lines are, as a whole, higher than the easterly-slope lines.

To this net resultant discharge from Long Island Sound into Upper Bay a very considerable importance has been attached. To quote Mitchell, "the circulation of the sea by way of the East River, although small in quantity, is the element which determines the superiority of New York Harbor over nearly all the 'sand-barred inlets' of the world. It is this circulation which keeps the port open in winter and sweeps the sand from its threshold."[21] In connection with the disposal of sewage, it was thought

[14] *Rept. Metropolitan Sewerage Commission of New York, April 30, 1914*, p. 558.
[15] *Ibid.*, pp. 558 and 562.
[16] *Ibid.*, pp. 558 and 563.
[17] Parsons, *op. cit.*, p. 2051.
[18] *Rept. Metropolitan Sewerage Commission of New York, April 30, 1914*, p. 587.
[19] Henry Mitchell: Circulation of the Sea Through New York Harbor, *Science*, Vol. 9, 1887, pp. 204–205.
[20] *U. S. Coast and Geodetic Survey Rept. for the Year Ending June, 1886*, Washington, D. C., 1887, p. 36.
[21] Mitchell, *op. cit.*, p. 205.

that this resultant flow played an important part in flushing out New York Harbor; and recently it has been suggested that the discharge from Long Island Sound be increased by the erection of tidal gates to shut off the return eastward flow through East River.[22]

A preponderance of about 400 million cubic feet in the ebb, or about 10 per cent of the tidal flow, was generally accepted until 1908, when at the instance of the Metropolitan Sewerage Commission of New York the Coast and Geodetic Survey investigated the matter anew, the question being turned over to the late R. A. Harris of the Division of Tides. From a mathematical discussion of the flow of water in open channels, in connection with the current observations that had up to that time been made in East River, he arrived at the conclusion that the volume of water flowing westerly was probably not more than one or two per cent greater than the volume flowing easterly.[23] This estimate would therefore make the net resultant discharge not over 100 million cubic feet per tidal cycle. Parsons[24] follows Harris and gives 80 million cubic feet as the net discharge per tidal cycle. But from current observations made by the Corps of Engineers of the U. S. Army in 1910 and 1911, in the vicinity of Hell Gate, Robinson derives figures[25] closely approximating Mitchell's.

From the large quantity of water circulating in the various channels of New York Harbor, an exaggerated notion of the flushing action of the waters in the harbor is frequently entertained. It is to be borne in mind that for the greater portion of the harbor the water that is returned on the flood is not clean sea water, but harbor water which had been carried to a lower portion of the harbor on the preceding ebb. In the section dealing with the distance traveled by a particle during a tidal cycle it was shown that with a current which at strength has a velocity of two knots, a particle will be carried a distance of about 48,000 feet, or eight geographic miles during the period of a single flood or ebb. If, therefore, the flood and ebb velocities were equal, a particle would merely move a given distance downstream on the ebb and return the same distance upstream on the flood. It is the excess of the ebb over the flood that finally carries a particle from the upper reaches of the harbor out past the Narrows and into the sea.

In the circulation of the waters in the harbor it is therefore the excess of the ebb volume over the flood that is the important feature. Two causes contribute to this ebb excess. The first and principal cause is the freshwater run-off from nearly 15,000 square miles of territory that drains into the Atlantic through New York Harbor, and the second is the excess of the flow coming from Long Island Sound which circulates through the Harlem, Hudson, and East Rivers and thence through the Narrows out to sea.

[22] S. A. Reeve: Cleansing New York Harbor, *Geogr. Rev.*, Vol. 12, 1922, pp. 420–23.
[23] *Rept. Metropolitan Sewerage Commission of New York, April 30, 1914*, p. 568.
[24] Parsons, *op. cit.*, p. 2041.
[25] *Rept. Metropolitan Sewerage Commission of New York, April 30, 1914*, p. 558.

THE ICE SHEET OF CENTRAL GREENLAND

A REVIEW OF THE WORK OF THE SWISS GREENLAND EXPEDITION*

By Charles F. Brooks
Clark University

Our knowledge of the physiography and meteorology of Greenland has been built up by laborious stages chiefly in the past two decades. The earliest information related to the easily accessible west coast where most of the Eskimos and Danish officials and traders live. Then followed the northwest coast, during the middle of the nineteenth century, through the expeditions in search of Sir John Franklin and later from various explorers whose main objective was the North Pole. The forbidding, ice-bound eastern coast was practically unknown until three or four decades ago, and even yet scientific expeditions have given us only reconnaissance reports.

Crossings of Greenland

The great glacier, known as the inland ice, covering some 715,400 of Greenland's 827,275 square miles, has for the most part proved too great a barrier to the explorers' zeal. A. E. Nordenskiöld in 1883 penetrated the interior from the middle of the west coast to a distance of more than 200 kilometers from the edge of the ice, and his Laplanders appear to have gone 100 kilometers farther still. Peary in 1886 traveled nearly 200 kilometers up on to the inland ice in the same region. Nansen in the autumn of 1888 actually crossed the southern ice dome, on a journey of more than 400 kilometers. Peary in 1892 and 1895 and Knud Rasmussen in 1912 and 1917 made long journeys across the northwestern portion of the inland ice. Also Mylius Erichsen in 1907 and Ejnar Mikklesen in 1910 traveled over the border of the inland ice of northeastern Greenland. Central Greenland was practically unknown until de Quervain's summer crossing of 1912 and J. P. Koch's traverse of the widest and highest part of the central ice dome in the spring of 1913 (see Fig. 1).[1]

With at least the preliminary results from all the scientific expeditions at his disposal, and with a wealth of information gained through personal exploration of the coasts, Lauge Koch has just presented a large-scale review of the physiography and geology of Greenland and the broad structural

* Alfred de Quervain, P. L. Mercanton, and others. Ergebnisse der Schweizerischen Grönlandexpedition, 1912–1913, xx and 402 pp.; maps, diagrs., ills. *Denkschr. Schweizerischen Naturforschenden Gesell.*, Vol. 53, Zurich, 1920.

[1] Cf. The Recent Crossings of Greenland, *Geogr. Journ.*, Vol. 42, 1913, pp. 545–550; CaptainKoch's Crossing of Greenland, *Bull. Amer. Geogr. Soc.*, Vol. 46, 1914, pp. 356–360.

relations of this continental island to North America and northwestern Europe.[2] Excluding a northwestern coastal belt of sedimentary rocks and a northeastern folded mountain chain, the rock surface of Greenland is a northwestward-sloping gneiss plateau to plain. Across it from Disco to Angmagssalik runs a great central depression associated with which are large areas of basalt. The depression is seen in the coast profiles, which here drop to sea level or near it from elevations of nearly 2000 meters to north and south, and also in the topography of the inland ice. The most productive glaciers form at the ends of the depression, for into it tends to converge ice from the two centers of glaciation which it separates. This situation adds greatly to the significance of the detailed glacial studies prosecuted by the Swiss expedition in this region, and to de Quervain's observations during his crossing, along the course of the depression.

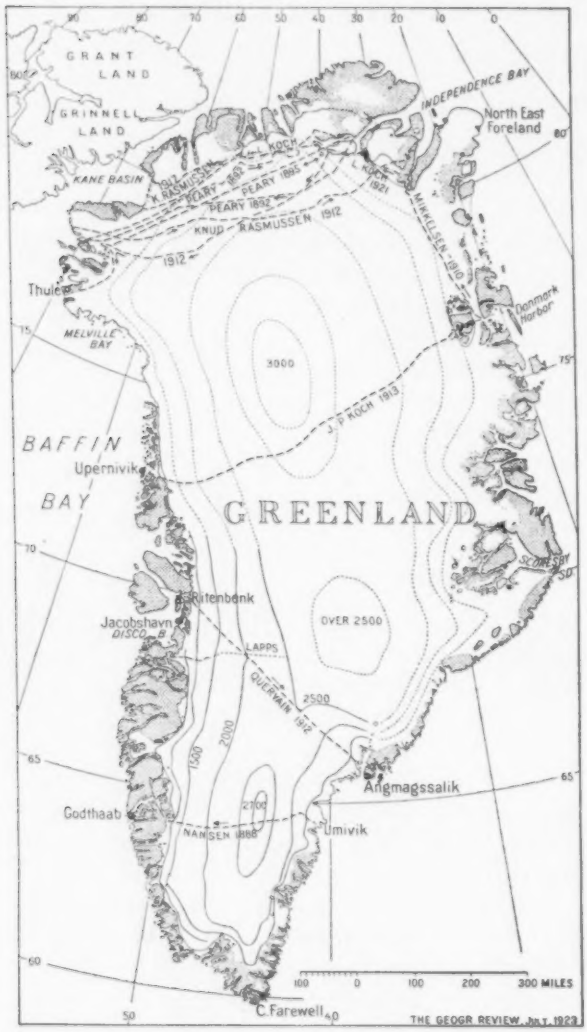

FIG. 1—Map of Greenland, showing the general topography of the inland ice. After Fig. 1, Pl. II, in de Quervain's report. The routes of explorers crossing the ice sheet are also shown. Scale of map approximately 1: 2,100,000.

ORGANIZATION OF DE QUERVAIN'S EXPEDITION

Dr. Alfred de Quervain had been so impressed with observations made during a short trip over the inland ice in 1909 that he organized an expedi-

[2] Lauge Koch: Some New Features in the Physiography and Geology of Greenland, *Journ. of Geol.*, Vol. 31, 1923, pp. 42–65. Koch (who accompanied Rasmussen in 1917) made a successful crossing in 1921. See *Geogr. Tidskrift*, Vol. 26, 1922, pp. 182–187.

tion for further study. One party, headed by de Quervain, crossed the inland ice from near Jakobshavn to Angmagssalik (see map). Another party, led by Dr. P. L. Mercanton, the Swiss glaciologist, spent the summer studying glacial phenomena and observing the weather on the western border of the ice sheet; and two members of his group, Dr. W. Jost and Dr. A. Stolberg, wintered in 1912–1913 at Godhavn to make aerological observations amplifying those of 1909. An eastern party, led by Dr. H. Hoessly, was established in the fall of 1911 to make anthropological studies of the Eskimos[3] and observe the weather till joined by the crossing party. A popular account of the expedition, "Quer durchs Grönlandeis" by A. de Quervain, was published in 1914. The full meteorological and glaciological results could not be published till after the international polar synoptic weather charts for 1912–1913 were issued, in 1916.

The Crossing

Well-laid plans prevented the suffering which sometimes befalls a polar explorer. Setting out from Jakobshavn the crossing party arrived on June 20 at the edge of the inland ice, at an altitude of nearly 600 meters. The way over the marginal belt of the ice sheet was difficult. The usual down-slope, brisk, southeast wind was faced. The ice was partly snow-covered and irregular and treacherous. During the first few days many ice swamps were encountered, and in one instance the party plunged through the ice into water 3 meters deep. There were a number of depressions 30 to 40 meters deep. Crevasses, in which annual (?) layers of ice 0.1 to 1.5 meters thick were visible, locally broke the surface to a distance of more than 100 kilometers along the route. Beyond this point the explorers got out of the zone of melting whence better progress was made on the smoother, firmer surface. The mountains on the west and the large cumulus clouds over the heated bare zone were now lost below the horizon, and for a fortnight only the smooth, undulating snow surface was seen and the clouds above, projected against a sky milky with the dust from Katmai. Occasionally, with a change of wind to an up-slope direction, snow fell. The crest was reached July 13 at 2500 meters after a march of 420 kilometers. On the down grade sails were set at times to a good, following wind, and rapid progress was made. The temperature rose above freezing again, and the snow became too soft for daytime travel. Once a few raindrops fell. To the east a previously unknown mountain region rose over the horizon. The highest peak (about 3400 meters, or 11,000 feet) was named Mt. Forel. It may overtop Petermann Peak, heretofore thought to be Greenland's highest mountain.[4] Descending rapidly to sea level the party left the inland ice on July 21 and soon, with aid from the eastern party, crossed to Ang-

[3] The first part of these studies, on the Eskimos of East Greenland, by H. Hoessly, was published in 1916.

[4] Lauge Koch, *op. cit.*, p. 45, designates Mt. Forel as "one of the highest peaks of Greenland . . . 2760 meters . . ."; but he does not give any reason for discounting de Quervain's observation of 3440±52m., nor does he say how or by whom the altitude he gives was obtained.

magssalik. A little rain on July 21 and a gale (föhn) off the inland ice with a temperature up to 61° F. added interest to the close of the successful crossing.

Topography of the Ice Sheet

A contour map was constructed for a strip 40 kilometers wide along the whole route. The actual altitude profile of the inland ice shows but little deviation from an ideal, smooth curve. The departures in form are explicable on the basis of the known topography on both sides and the probable surface form of the underlying rock. Some of the irregularities may be ascribed, however, to secondary features resulting from uneven melting and drainage in the border zone.

The form of the surface in the marginal zones was in general one of broad terraces many of which contained lakes a kilometer wide and two or three kilometers long. On the western slope in the first 150 kilometers there were about 10 terraces, and in the next 100 kilometers along the route there was a broad plain followed by four more steps. The steps of the eastern slope were similar to those of the west, but were steeper and without meltwater lakes. The central portion, extending 200 kilometers from an altitude of 2200 meters on the west to 2300 meters on the east, sloped gently from the divide. Its even surface was ruffled only by small snow dunes 2 to 15 centimeters high. The great fiord system of the west coast evidently extends more than 100 kilometers inland under the ice, as is shown by the surface form. The thickness of the ice is not known; over peaks it may be only a few hundred meters.

Summer Weather on the Ice Sheet

In the zones of melting the temperatures averaged just below freezing, and the range was generally small. The midday temperature was kept down by the insatiable heat requirements of the melting snow and ice and at midnight was held fairly steady by the large yield of latent heat from the freezing surface. In the central zone of no melting, however, the temperatures averaged only 14° F.; and the range was great, the extremes being −7° F. and 25° F. This cold air is the source of the characteristic down-slope wind.[5] At times this wind, usually moderate in strength, increased to storm force and at others weakened or even reversed under the influence of changes in the general pressure gradients. A strong gradient across Greenland resulted in föhn conditions, with snow on the up-slope and a warm, dry wind on the down-slope. Important though these föhn winds are, both in bringing snowfall and even rain to the ice sheet and in melting its margins, they are foreign to the prevailing quiet steadiness of the weather.

[5] The prevalence of down-slope winds, even in midsummer, is strikingly in accordance with Hobbs' theory of the glacial anticyclone. See review in *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, p. 963.

Summer Weather Along the West Coast and Ice Front

The weather of the bare coastal zone on the west is closely related to that of the inland ice. The general meteorological situation over the bare coastal zone in summer is about the reverse of that over the ice cap. The bare zone is much heated by the sun and thus is a warm belt between the cold of the inland ice on the one side and the cold of the iceberg-dotted water (Davis Strait) on the other. On account of the expansion and lateral overflow of the heated air, pressure gradients are established toward the warm zone, resulting in a daily sea breeze on the western portion and a daytime intensification of the fall wind off the ice, with rising air between. This circulation gives the coasts chilly, cloudy weather and causes some daytime cloudiness over the bare zone.

Alimentation of the Ice Sheet

Three zones of ice and snow were found on the ice sheet: (1) a border zone where the abundant melt water had so penetrated the snow as to prevent any identification of annual layers by differences in density, (2) an intermediate zone where summer melting formed a hard crust on top of the annual accumulation of snow, and (3) a far interior zone where there was no summer melting to mark the annual layers. The outer zone includes not only the belt in which the snow of winter melts completely during the summer but also a strip in which such summer melting is not complete. The usual limit of complete melting is called the snow line. The expedition crossed Greenland before the end of the melting season, and snow was found on all parts of the ice sheet, hence the snow line could be located only through indirect observations. One clue was the inward extent of melt-water lakes. These were found to a distance of 107 kilometers along the route (about 90 kilometers from the edge directly down the slope), up to an elevation of 1530 meters. It is a fair presumption that such lakes could not form on a snow foundation and, therefore, that they must mark the zone where ice from the interior is melting. From observation of the size of the ice granules, which are large in glacial ice, small in new *névé*, it was deduced that the perennial snow line was not less than 80 nor more than 120 kilometers along the crossing route from the western margin of the inland ice. These two lines of evidence reinforce each other in indicating a snow line on the western side of about 1450–1500 meters altitude and 100 kilometers inward on the route, or 80 kilometers directly in from the margin. The other portion of the outer zone of considerable melting extended to 50 kilometers farther inland, where the altitude was 1800 meters. Here it became possible to distinguish the annual accumulation. On the western slope at 8 stations between 1831 and 2300 meters the average water equivalent was found to be 36.2 centimeters, the successive values being 35.0, 33.5, 26.5, (25), 34.2, 54.5, 44.0, and 39.5. On the eastern slope corresponding determinations were made at 6 stations from 1236 to 2258

meters. These averaged 33.6 centimeters of water content, and the individual values from lower to higher stations were 39.2, 35.3, 34.0, 33.6, 33.6, and 26.1. The higher values at lower elevations on the eastern side are a result of the much heavier snowfall here (compare 114 centimeters precipitation at Angmagssalik with 22.4 centimeters at Jakobshavn from July, 1911, to June, 1912). On the east the snow line is depressed to 1100 or 1000 meters above sea level. If the trends of the snow accumulation on both slopes are projected to the crest the amount there might reasonably be taken as between 25 and 30 centimeters. De Quervain takes 35 centimeters as a reasonable figure to represent the annual (water) increment in the interior of the inland ice (zones 2 and 3).

To obtain the probable precipitation for the year ending June 30, 1912, the 5.5 centimeters computed evaporation must be added, making 40.5 centimeters. As the precipitation at Jakobshavn, on the west, for these 12 months was 11 per cent below the average, while that at Angmagssalik, on the east, was 14 per cent above the average, it seems fair to assume that the precipitation of the interior for this year represents about average conditions. Current maps of the precipitation of Greenland evidently need revision, for this is much more than our maps show.[6]

The height of the snow line on the western slope, 1450–1500 meters, is even higher than that on glaciers on the northern slope of the Alps, 22° of latitude nearer the equator. The snow line in the interior is higher than on the coast at Disco Island (1000 m.) or near Angmagssalik (not higher than 1100–1000 m.). The nearer the pole the less does altitude control the snow line, and the more does the exposure affect it. The decreasing precipitation toward the interior, the greater brightness of the sun on föhn days, and the general anticyclonic weather are the important factors in the high snow line of inner Greenland.

Movement and Ablation of the Ice Front

The sunlight, the temperature, and the wind together melted the ice front back about as fast as the ice moved forward. The rate of movement of the ice was small in the summer of 1912. It was not even 6 centimeters a day at the most rapid point, 1.3 kilometers from the front, and less than three-quarters of a centimeter at the moraine crest (a greater movement was shown by individual tongues where the slope was steep). From the ablation of 1.25 meters at 625 and 650 meters, and 1.00 meter at 675 meters, in 39 days, a total summer loss on this front was taken to be 2.3 meters. This

[6] As a rough approximation based on de Quervain's observations and some observations cited by reviewers of his work (Brückner, *Zeitschr. für Gletscherkunde*, Vol. 12, 1922, pp. 152–153; de Martonne, *Ann. de Géogr.*, Vol. 32, 1923, p. 82) the following may be presented as a closer approach to the truth than the indications of current maps: The 100-cm., or 40-inch, line should run from Angmagssalik (100 cm. average precipitation) to a little north of Ivigtut (120 cm.); the 50-cm., or 20-inch, line should reach from the east coast north of Angmagssalik, perhaps at latitude 70°, to the west coast just north of Godthaab (65 cm.); the 25-cm., or 10-inch, line from about Franz Joseph Fiord to Jakobshavn (25 cm.) and thence north of Disco; and the 12.5-cm., or 5-inch, line could loop south from Danmarkshavn across the center of Greenland at latitude 73° to the west coast at Cape Alexander.

corresponds closely to Drygalski's figure, 2 meters. Melting was very rapid under föhn conditions, as June 29–July 1, when föhn and rain took off 19 centimeters of ice.

Present Condition of the Ice Sheet in South Central Greenland

Is the Greenlandic ice sheet a relic of the glacial period, or is the present snowfall on it sufficient to prevent melting and evaporation from reducing it from year to year? Comparison of the rate at which ice is lost at the edge of the sheet with the rate of accumulation in the interior provides some basis for a quantitative answer to this question. Data are taken for the western section. The western accumulator extends from the snow line, 80 kilometers from the edge of the ice, to a line somewhere beyond the crest. Nansen and de Quervain agree that the highest land under the ice in this part of Greenland is near the east coast, and de Quervain in Figure 2 has presented his idea of the rock foundation under the route on which he crossed. It is quite evident that most of the ice from 20 or even 30 kilo-

Fig. 2—Schematic representation of the relation of the inland ice to the west and east coasts, from latitude 70° on the west to latitude 66° on the east. After de Quervain, p. 66.

meters east of the crest must go west. The annual addition of ice on the accumulator must be computed for three belts: (1) the outermost, between the snow line and 1831 meters; (2) the zone between the stations at 1831 and 2399 meters in which measurements of the annual addition could be made; and (3) the upper zone in which there was no direct way of determining the annual addition. For the second zone observations indicate a total of about 36 centimeters water content of ice added annually. For the outer zone the addition must vary between 0 at the snow line and 35 centimeters as observed at 1831 meters—say an average of 18 centimeters. For the upper zone, we may take 40 for the western edge and 25 for the eastern, or about 33 for the average. The widths of these zones along the route are approximately 60, 180, and 90 or 100, or roughly as 2, 6, and 3. The weighted average for the whole accumulator, 330 or 340 kilometers along the route, or actually 270 kilometers broad, is 32 centimeters water, or nearly 36 centimeters ice. As this accumulation is dissipated in the outer zone only 80 kilometers wide, the average loss from the dissipator must be 36 x 270/80, or 121 centimeters to balance.[7]

[7] De Quervain used 40 cm. as the addition of ice on the accumulator, for he did not allow for the reduced addition on the margin and at the summit. Also he used 330 km. as his traverse of the western portion of the accumulator. Brückner in his review (*loc. cit.*, p. 155) corrects this to 320; also, not understanding that the 40 cm. stood for ice, he would have used 35 and obtained 112 cm. in his computation. Mercanton takes 440 km. as the total distance to the summit of the ice sheet. It so happens that my figure of 335 km. for the party's traverse of the western accumulator lies between de Quervain's and Mercanton's, although I added on 25 km. on the eastern slope, which they did not plan to include.

As mentioned earlier, the annual ablation at the margin of the ice sheet is set at 2 meters by Drygalski and 2.3 meters by Mercanton. Assuming that the rate of ablation is directly proportional to the altitude and that it becomes 0 at the snow line, the average ablation is 83 or 95 centimeters over the dissipator.[8] If 36 centimeters is taken as the addition of ice to the accumulator, and 95 centimeters as the ablation from the dissipator, and if the glacier is supposed to be in equilibrium the snow line should be at 36 x 270/95, or 102 kilometers from the western margin instead of at 80 kilometers as observed.[9] De Quervain ascribed the discrepancy between the larger accumulation and the smaller ablation to the amount of ice carried away in icebergs, estimated at 10 to 100 cubic kilometers per year from the whole west coast. These amounts run up to 25 per cent of the amount lost by ablation. But for the portion of the glacier considered there is practically no loss in the form of icebergs. Some tongues, however, descend to lower elevations where the melting is faster, a rate nearly twice that at 650 meters having been observed at 360 meters altitude. In any event, the observed accumulation of ice was greater than the observed dissipation, which would seem to indicate that the glacier is decidedly not a relic but is fully maintaining itself in its present extent.

We may also ask whether such a glacier could start under present general climatic and topographic conditions. It does not seem likely that the ice could have started forming in the interior, for the snowfall on an upland so far from the coast would be insufficient to survive the summer melting. The eastern mountains, however, rise well above the snow line. These may have been responsible for the first accumulations of ice, till the sheet grew to a height where it became its own accumulator and continued to rise till the elevation in the interior exceeded that on the mountains nearer the coast. In this it corresponds to the northwestern European ice sheet, the summit of which was to the east (inland) of the crest of the Scandinavian highlands, and also to that of Labrador where the summit was west (inland) of the highest land. The ice sheet of Greenland could not be built up under present conditions without the aid of the changes which the rising accumulation of ice on the eastern mountains would bring about. The ice plateau now divides the polar circulation markedly. Without it the subpolar cyclones would cross Greenland much more commonly than at present, with consequent higher temperatures and heavier precipitation. De Quervain believes that the influence of the heavier precipitation would preponderate over that of the higher temperature and result in the formation of a new ice sheet. Under present conditions the ice sheet seems to be stable. If it should be built up higher it would favor a stronger outward circulation and be more effective in preventing ingress of cyclonic, snow-bearing winds.

[8] This average is less than the arithmetical mean of 2 and 0 or 2.3 and 0, or 1.0 and 1.15 m. taken by de Quervain, for about ⅔ of the increase in altitude comes in the first half of the distance.

[9] Mercanton goes through this computation on an erroneous assumption of 2.3 m. as the ablation over the entire dissipator and arrives at the impossible figure of 65 km. as the distance of the snow line inward along the route (p. 271).

This would reduce its sustenance and thus bring about a state of equilibrium. Where Nansen crossed, farther south, the slopes were steeper and the interior higher, owing probably to the heavier snowfall as well as to the generally greater altitude of the land in the south. There seems to be another highland and heavy-snowfall ice dome just north of the eastern mountain region discovered by de Quervain and named by him Switzerland. The central ice dome of Greenland appears to be but little higher (Koch's and Wegener's maximum was just over 3000 meters) even though the land is much wider.[10] Northward and toward the interior the snowfall must greatly decrease, apparently to only 30 centimeters at the summit of Koch's crossing. If the density of this snow were about the same as that found near the crest of de Quervain's route, namely 0.44, the water equivalent of the 30 centimeters would be only about 13 centimeters, or less than half that on the crest farther south. Further exploration is called for, particularly in the region between Sermilik Fiord and Scoresby Sound (latitude 70° N.) where the mountains and the inland ice rise well above the snow line.

Discussion of other portions of the report must be left for reviews in more specialized journals.[11] The observations made along the front of the inland ice will be found of exceptional interest to the physiographer, as showing the conditions which may have obtained on the glacial fronts of America and Europe not many thousand years ago. So, also, the painstaking aerological observations made at Godhavn during the Arctic winter, and their comparison with similar free-air observations made in northeastern Greenland, Iceland, and Spitzbergen at the same time, will interest the meteorologist as definitely disproving the existence of a general circumpolar whirl in the Arctic.

[10] Lauge Koch, *op. cit.*, and de Quervain do not agree as to the probable locations and extents of the ice domes of central Greenland. Koch places the Switzerland dome very near the mountains and the coast and greatly restricts its size, and he indicates the central dome to the south of J. P. Koch's crossing instead of to the north as de Quervain has it. Since L. Koch's map (his Fig. 4) does not correspond to the observations de Quervain made along the route he traversed, the reviewer is inclined to favor de Quervain's map (see Fig. 1).

[11] Further details of the physiography will be discussed by the present reviewer in a forthcoming number of the *Journal of Geology* and of the meteorological results in the *Monthly Weather Review*.

SOME RECENT TOPOGRAPHIC MAPS OF THE COASTAL PLAIN OF GEORGIA AND FLORIDA

By Roland M. Harper

Geological Survey of Alabama

Eight or ten years ago the only published government topographic maps of any considerable part of the coastal plain of the United States between Maryland, which was completely mapped, and the Mississippi River were parts of two United States Geological Survey sheets extending from Maryland across the Potomac River into Virginia, one around Norfolk, several contiguous ones in eastern North Carolina, parts of one 30-minute and of two 15-minute quadrangles along the fall line near Milledgeville and Columbus, Ga., several contiguous sheets in the hard-rock phosphate region of Florida, and a few scattered areas in Mississippi and Louisiana. This dearth of detailed topographic information is doubtless largely responsible for the treatment of the very diversified coastal plain as a unit by nearly all northern physiographers who have had occasion to discuss it.

The World War made additional maps of the country near the Atlantic coast very desirable, and on March 26, 1917, Congress made a special appropriation for topographic mapping, to be done jointly by the United States Geological Survey and the War Department. Work was prosecuted actively for the next few years, with the result that Delaware and the coastal plain of Virginia are now completely mapped (except for the two Eastern Shore counties of Virginia), together with large areas in southern South Carolina and eastern Georgia and a few sheets in the northeastern corner of Florida. Now that the topographic work in these states has halted again, at least temporarily, it will be appropriate to review the results as far as they relate to Georgia and Florida.

The new maps are all 15-minute quadrangles with a scale of 1:62,500, or nearly a mile to the inch. Most of those in the Eocene red hills and northward have a contour interval of 20 feet, and those farther south 10 feet. All or nearly all can be had with green overprint showing woodland (in a few cases making a distinction between forest and brush, as is done more commonly in the West).[1]

Maps of Georgia

The maps for the coastal plain of Georgia make a continuous strip two sheets wide between the meridians of 81° 30′ and 82° W. from the fall line

[1] The use of 15-minute quadrangles (with a scale of 1 : 62,500) for such level and thinly settled country as most of Florida gives more detail than is really needed at present and makes a set of maps for a given area or trip just four times as bulky and expensive as the usual 30-minute quadrangles would be. The green overprint for woodland, although useful to botanists and others in regions that are mostly under cultivation, is almost superfluous in Florida, where it covers nearly the whole map and obscures the other features.

to the St. Mary's River at the southern border of the state, except that one sheet just east of Jesup is lacking. Farther east there are four or five sheets between 81° 15′ and 81° 30′, the two northernmost being partly in South Carolina and the next nearly all in Effingham County; then comes a gap of a degree and a quarter of latitude between that and the Cumberland Island sheet near the southeastern corner of the state. The lack of topographic maps between Cumberland Island and Savannah is, however, largely compensated by the Coast Survey charts, which have been in existence for many years, and by government soil maps of Chatham and Glynn Counties. West of longitude 82° there are four more sheets north of latitude 33° and east of longitude 82° 30′, connecting with the sheets in the Piedmont region which were published long ago, and three south of latitude 31° and west of longitude 82°; the Milledgeville sheet (published in 1912, before any adjacent areas) partly in the Piedmont and partly in the coastal plain; the Irwinton sheet (surveyed before the war and published in 1920) immediately south of it; the southeastern corner of the Talbotton sheet (published in 1907, with a scale of 1:125,000); and the Columbus sheet (published in 1908) just south of the western half of the last.

These maps cover parts of several different natural regions which the writer and others had long ago distinguished in reconnaissance work, and in some cases they make it possible to locate the regional boundaries more accurately than has been done heretofore.[2]

Parts of the fall-line sand-hill belt are shown on the Hephzibah, Harlem, Milledgeville, and Talbotton sheets, which ought to dispel the impression given by some current geographical texts that the fall line is a seaward-facing scarp or terrace. The sand hills are not noticeably lower than the adjacent Piedmont region. They are, for instance, about 400 feet above sea level a few miles west of Augusta and 700 feet south of Talbotton. The topography is so similar that it would be almost impossible to trace the fall line across Georgia by these maps alone. The important difference between the two regions is in the soil, one having mostly residual red clay and the other loose whitish sand.

The Cretaceous or blue marl region of western Georgia occupies most of the Columbus sheet. It is a topographically mature region, with some of the valleys wider than the ridges, and very little swamp.

The Eocene red hills are represented by the Irwinton, Stapleton, Gough, and Green's Cut sheets and small parts of a few others, all with 20-foot contours except the Gough, which has 10-foot contours. On comparing one of these sheets with one for the Piedmont (most of which have 50-foot contours and half the scale) no great difference is noticed except that the coastal-plain areas are a little more swampy; but if the same scale and contour intervals were used for both regions the smaller local relief in the coastal plain would be evident. Some state maps, including the latest United States Geological Survey base map, show a considerable body of water in

[2] For a recent regional map of Georgia see *Geogr. Rev.*, Vol. 10, 1920, p. 342.

the northern part of Wilkinson County called Black Lake; but the Irwinton sheet shows it to be nothing but a bayou or old channel at the edge of the Oconee River swamp, hardly worth mentioning on a state map.

The lime-sink region presumably crosses the Millen and Hilltonia (Hiltonia?) sheets (which have 10-foot contours); but it is much less distinct topographically and otherwise in eastern than in western Georgia, and in South Carolina it can be distinguished with difficulty if at all. Similarly the Altamaha Grit escarpment, which rises about 150 feet above the lime-sink region in some places in southwestern Georgia, is hardly noticeable east of longitude 82°, the area for which we have maps.

The Altamaha Grit or rolling wire-grass country is well displayed for the first time on the Rocky Ford, Oliver, Statesboro, Brooklet, and Claxton sheets. Its topography is quite different from that of adjacent regions and was characterized by Otto Veatch[3] as "unlike that of any other coastal-plain formation"; but it is merely a submaturely dissected region with occasional undissected uplands dotted with shallow ponds (less frequent in the area mapped than farther west), which may or may not be due to the dissolving out of limestone which lies buried beneath several hundred feet of non-calcareous sands and clays. A large part of the difference in appearance between the Altamaha Grit region and other hilly parts of the coastal plain, or the Piedmont, is—or was—due to the vegetation, which is typically park-like—open pine forests on uplands and dense bushy swamps in lowlands. But the farmers are rapidly clearing away the forests—the improved land having increased from about 13 per cent in 1900, when the writer first visited the region, to 32 per cent in 1920—so that the difference must be sought more and more in the soil, which is not easily changed. In the southwestern quarter of the Claxton sheet, in Evans and Tattnall Counties, is an undissected flat upland several square miles in extent and about 190 feet above sea level, dotted with shallow cypress ponds.[4]

Toward the coast the rolling wire-grass country passes, sometimes gradually and sometimes rather abruptly, into the flat pine lands. The transition, corresponding approximately with the 100-foot contour north of the Altamaha River, is well shown on the Brooklet and Glennville sheets and not quite so well on the Claxton sheet. The drop from rolling to flat country in southeastern Georgia was noticed by William Bartram[5] about the time of the Revolution and is regarded by Veatch as a marine terrace.[6] But the explanation is not so simple, for in northern Florida the same flat pine region is higher than the hammock belt immediately west of it. The

[3] Otto Veatch: Altamaha Formation of the Coastal Plain of Georgia, *Science*, Vol. 27 (N. S.), 1908, pp. 71–74; reference on p. 71.

[4] R. M. Harper: A Phytogeographical Sketch of the Altamaha Grit Region of the Coastal Plain of Georgia, *Annals New York Acad. of Sci.*, Vol. 17, 1906–07, pp. 1–414; reference on p. 24.

[5] William Bartram: Travels Through North and South Carolina, Georgia, East and West Florida, the Cherokee Country, the Extensive Territories of the Muscogulges, or Creek Confederacy, and the Country of the Chactaws, Philadelphia, 1st edit., 1791, pp. 28 and 32.

[6] Otto Veatch: The Geology of the Coastal Plain of Georgia, *Geol. Survey of Georgia Bull. 26*, Atlanta, 1911, pp. 25–57; reference on pp. 35–36.

soil is much the same in the flat as in the rolling country, sandy loams prevailing in both.

The sheets from latitude 32° to the Florida line cover a pretty flat country, mostly less than 100 feet above sea level, with large areas of swamp but diversified by a few interesting features. Foremost of these is Trail Ridge, which begins a few miles west of Jesup, passes southward parallel to the coast through the unmapped area west of longitude 82° for fifteen or twenty miles and then through the middle of the Folkston, Moniac, and Macclenny sheets and on into Florida (Fig. 1). This ridge has been commented on by several writers[7] but never yet satisfactorily explained. Except where the Satilla and St. Mary's Rivers cut through it the crest of Trail Ridge ranges from about 130 to 175 feet above sea level in Georgia and over 200 feet in Florida, its eastern base from about 60 to 100 feet, and its western base from about 120 to 130. Its northern extremity seems to be south of the Altamaha River, just off the area covered by the present topographic maps, but if it continued a little farther in the same direction it would merge into the low scarp at the coastward edge of the Altamaha Grit region already mentioned. At its southern extremity in Florida it runs into another regional boundary, the western edge of the peninsular lake region. Most of the way across the Folkston and Moniac sheets Okefinokee Swamp touches the western base of the ridge, as if dammed up by it. These two sheets show approximately the eastern third of the swamp, and by means of the green overprint the wooded portions are plainly distinguished from the marshy "prairies."

On the Hinesville sheet there is a low scarp parallel to the coast, with a descent of about 50 feet in a mile, corresponding with the boundary between the Okefinokee and Satilla terraces of Veatch and, at this point at least, with the inner edge of the coast strip, which is characterized by more or less clayey and marly soil contrasting with the prevailing sand farther inland. On the northeast and south of the Hinesville sheet this scarp runs off into areas not yet mapped, but it may be connected with a similar scarp which runs along the western edge of Glynn County and thence southward into Florida. (See the Everett City, Nahunta, and Boulogne sheets.) The old road from Savannah to Florida, traveled by Bartram and other eighteenth-century explorers, follows this low sandy elevation for miles. In Camden County it is a ridge rather than a terrace scarp, and the Satilla River runs parallel to it for about twenty miles before breaking through.

The Cumberland Island sheet takes in nearly the whole of the island for which it is named, which differs from all other islands on the Atlantic coast south of New York, as far as known, in its elevation—over 40 feet in places—and in appearing to be a cut-off part of the mainland rather than a barrier beach built up by wind and waves. It differs further from the other islands

[7] For references to earlier literature see R. M. Harper: Geography and Vegetation of Northern Florida, *Sixth Ann. Rept. Florida Geol. Survey*, Tallahassee, 1914, pp. 163–437; reference on p. 329; *idem:* Georgia Coastal Plain Geology and Physiography, *Bull. Amer. Geogr. Soc.*, Vol. 46, 1914, pp. 920–923; reference on p. 923.

in being the home of long-leaf pine, blackjack oak, and a species of the rodent genus *Geomys*.[8]

Maps of Florida

For Florida previous to the World War there were only seven topographic sheets, all 15-minute quadrangles with 10-foot contours, surveyed about thirty years ago, soon after the discovery of phosphate. These cover a considerable part of the peninsular lime-sink or hard-rock phosphate region, in the vicinity of Gainesville, Ocala, and Inverness, and small parts of neighboring regions.[9] Work had been begun before the war on some areas a little farther east, and the Palatka and Interlachen sheets (latitude 29° 30′—29° 45′, longitude 81° 30′—82°) were published in 1915 and 1916. The war-time activity resulted in the mapping of the whole northeastern corner of the state, north of latitude 30° and east of longitude 82° 15′, fourteen sheets, including some partly in Georgia which have been noted above. All of these sheets have the same scale and the same contour interval as the older ones.

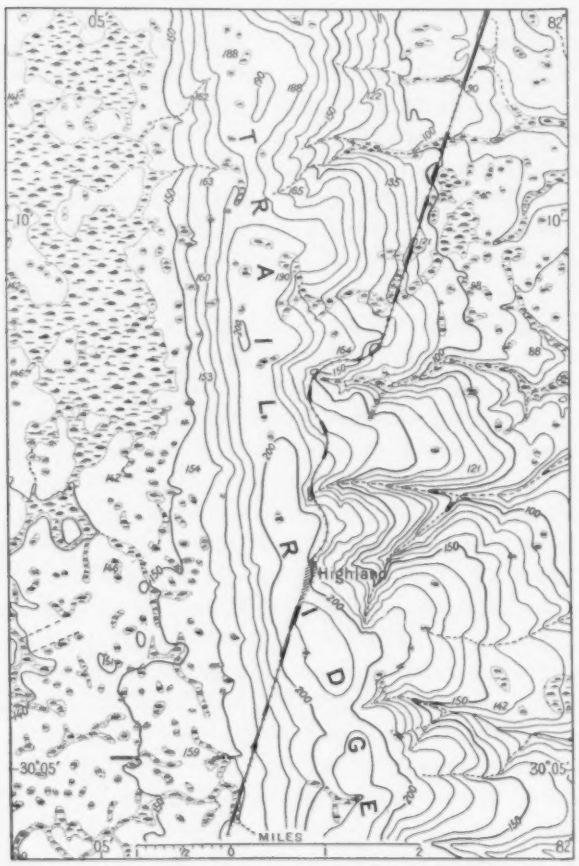

FIG. 1—A part of the Trail Ridge illustrating characteristic topography. Redrawn from the Lawtey quadrangle (Florida). Scale 1:125,000.

Of the new maps the three westernmost show typical portions of Trail

[8] R. M. Harper: Notes on the Distribution of the Southeastern Salamanders (*Geomys Tuza* and Allies). *Science*, Vol. 35 (N. S.), 1912, pp. 115–119; reference on p. 117.

[9] For a preliminary regional map of Florida see R. M. Harper: Preliminary Report on the Peat Deposits of Florida, *Third Ann. Rept. Florida Geol. Survey*, Tallahassee, 1910, pp. 197–375 (map on Pl. 16, facing p. 204). An adaptation of this map on a smaller scale, with some revisions based on subsequent explorations, was published in the *Geogr. Rev.*, Vol. 2, 1916, p. 362. The original map was copied pretty closely by Soper and Osbon in *U. S. Geol. Survey Bull. 728*, Washington, D. C., 1922 (Pl. 18, facing p. 200), but some of the regional names were needlessly altered there, and no use was made of the work of the writer in the 6th and 13th annual reports where important changes were made in the mapping of northern and central Florida.

Ridge; but its highest point, about 250 feet above sea level, is in an area not yet mapped, a little farther south, near the northern end of the lake region. On the Lawtey sheet a railroad which is otherwise straight for many miles through the flatwoods on either side had to make several curves in ascending the eastern slope of the ridge near Highland (Fig. 1).

Immediately east of these are the Hilliard, Cambon, and Middleburg sheets, all typical flatwoods country, with the larger streams in valleys as

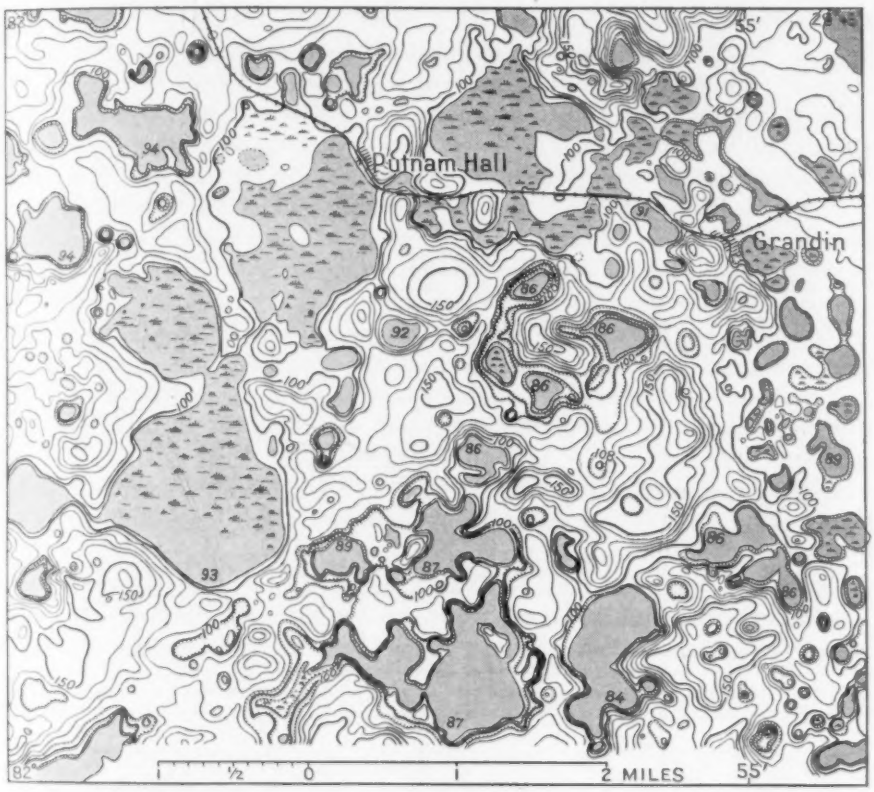

FIG. 2—A part of the Florida lakes region illustrating characteristic topography. Redrawn from the Interlachen quadrangle (Florida). Scale approximately 1:80,000.

much as 50 feet deep in places, and innumerable shallow swamps, cypress ponds, or "bays" on the undissected uplands 70 to 100 feet above sea level and 25 or 30 miles from the coast. The low ridge or terrace mentioned above as running parallel to the coast in Georgia is barely recognizable near Marietta on the Cambon sheet. The soil of the flatwoods is mostly so damp and sour that very little of it is cultivated yet, and the green overprint for woodland covers at least 95 per cent of the area of these sheets.

On the next three sheets on the east the flatwoods are interrupted by the St. John's River, here an estuary one to two miles wide, and the tidal

marshes of a few smaller streams north of it. The three easternmost sheets show the usual features of a low sandy coast, a nearly straight strip of beach and dune, with salt marshes back of it, both beach and marsh being rather narrow in this latitude.

The Palatka and Interlachen sheets, separated from those just mentioned by an unmapped east-and-west strip 15 minutes wide, are the only ones thus far that show any of the beautiful lake region of peninsular Florida, except that the old Citra and Ocala sheets barely touch its ill-defined western edge. The lake region includes the greater part of the Interlachen sheet (Fig. 2) and the highlands in the southern part of the Palatka sheet. In former years, when the lake region was not so well understood as now, the old topographic maps of the lime-sink region farther west were thought to be representative of it.[10] The differences between the two regions as far as surface configuration is concerned are not very marked; but the lake region has many more bodies of water, and their level fluctuates much less with the seasons than it does in the lime-sink region.[11] The abundance of lakes in parts of the lake region not yet covered by topographic maps can be seen on the soil maps of Putnam and Orange Counties, published by the United States Bureau of Soils in 1916 and 1922 respectively. The southern part of the former and the western part of the latter are in the lake region.

Although a few feeble attempts have been made to explain the characteristic topography of the Florida lake region, its origin is still practically an unsolved problem.[12] Very few physiographers have ever seen this most interesting region, probably because most of those in this country teach in northern colleges and are free only in summer, which is the rainy season in Florida. It is a remarkable fact that the northern end of the lake region merges into the southern end of Trail Ridge (in the unmapped strip seventeen miles wide, unfortunately), so that when one of these topographic features is explained it ought to give an important clue to the other.

[10] See G. C. Matson and F. G. Clapp: A Preliminary Report on the Geology of Florida with Special Reference to the Stratigraphy, *Second Ann. Rept. Florida Geol. Survey*, Tallahassee, 1909, pp. 21–173; reference on pp. 32–33.

G. C. Matson and Samuel Sanford: Geology and Ground Waters of Florida, *U. S. Geol. Survey Water-Supply Paper 319*, Washington, D. C., 1913, pp. 25–26 (reviewed in *Geogr. Rev.*, Vol. 4, 1917, pp. 224–226).

[11] For a discussion of other differences see R. M. Harper: Geography of Central Florida, *Thirteenth Ann. Rept. Florida Geol. Survey*, Tallahassee, 1921, pp. 71–307; references on pp. 95–103 and 119–129.

[12] Some of the literature on the subject is referred to on pages 161–162 of the report cited in footnote 11.

AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April and Elections to Fellowship. Meetings of the American Geographical Society were held March 20, April 10, and April 24 at the Engineering Societies' Building, 29 West Thirty-ninth Street, the speakers at the respective meetings being Mr. T. Alexander Barnes, Mr. Carveth Wells, and Lieutenant-Colonel William Warfield. Mr. Barnes, author of "The Wonderland of the Eastern Congo" (1922), spoke on "The Eastern Congo and the Land of the Giant Craters." Mr. Wells gave experiences from his commission under the British Government in Malaya in "My Six Years in the Jungle of Malay." The address of Colonel Warfield, formerly of the U. S. Diplomatic Service and the American Red Cross, who has lived and traveled in all the countries of the Balkan Peninsula, was "An Intimate View of the Balkans."

At the meetings of March and April, President Greenough presiding, there were presented with the approval of the Council the names of 68 candidates, who were duly elected as Fellows of the Society.

A Change in the By-Laws of the Society. At the regular meeting of the Society on March 20, at the Engineering Societies Building, 29 West Thirty-ninth Street, there was presented in writing and approved a proposal to make a single change in the By-laws.

"Resolved that an amendment to the By-laws, having been proposed at the regular meeting of the Society on February 20 and approved by the Council on March 15, is hereby adopted as follows:

"That By-law Chapter 3, Section 3, be changed by striking out the words 'nine Fellows of the Society' and substituting therefor 'seven members of the Council'."

Election of Dr. E. Deville to Corresponding Membership. At the meeting of the Society held on April 24 Dr. E. Deville was elected a Corresponding Member. Dr. Deville is a native of France. For several years he served in the French Navy and had charge of extensive hydrographic surveys in the Pacific. He went to Canada in 1874 and entered the service of the Canadian government, rising to the position of Surveyor General of Canada. Recently he has been placed in charge of the Board of Topographical Surveys and Maps, with the title of Director General of Surveys. He is also President of the National Research Committee of Canada and was a delegate from Canada to the conference of the International Geodetic and Geophysical Union in Rome, last May. He is the author of several publications on astronomical and surveying subjects.

Presentation of the Charles P. Daly Medal to Ernest de K. Leffingwell. On March 21, 1923, Mr. Ernest de K. Leffingwell was presented with the Charles P. Daly Medal of the American Geographical Society, the award of which was announced in the April number of the *Geographical Review* (p. 295). The ceremony took place at an Assembly of the University of California, Southern Branch, Los Angeles. Dr. Ernest C. Moore, President of the University, presented the medal and spoke as follows:

"I am commissioned by the American Geographical Society, in its name and on its behalf, to perform a most agreeable agency, that of presenting to you, sir, the Charles P. Daly Gold Medal of that Society for the year 1922.

"Eight years, from 1906 to 1914, you spent in the arctic North upon your self-imposed task—carried on, much of it, without any companion, without technical assistance, and at your own expense—of studying intensively, surveying, and mapping the hitherto almost unknown and altogether unmapped coast of northern Alaska between the Colville River and the International Boundary. Fortitude and a relentless struggle with almost insuperable hardships characterized your undertaking, and, in spite of enormous handicaps, the contribution to geological and geographical knowledge which you were able to

make is of great importance. The results of your surveys and observations, published by the Geological Survey as *Professional Paper 109*, 'The Canning River Region of Northern Alaska,' is distinctively your own contribution to science, and through it you have transformed one more region of the earth from an unknown land to a country whose shore line is accurately measured and determined, whose terrain is sketched, and whose fauna and flora are described. Of particular interest to your colleagues and of special value to science is your Theory of the Formation of Ground Ice, which the experiences of nine summers spent upon the north shore of Alaska have enabled you to put forward.

"Your self-denying and arduous labors have already earned for you the Patron's Medal of the Royal Geographical Society of Great Britain (1922). It is now my privilege, on behalf of your own countrymen, your fellow American scientists of the American Geographical Society, to ask your acceptance of this token of its appreciation, of its desire to add your name to the distinguished company of those who have been awarded the Charles P. Daly Medal."

Award of the David Livingstone Centenary Medal to Griffith Taylor. Announcement is made of the award of the David Livingstone Centenary Medal for 1923 to Griffith Taylor, Associate Professor of Geography in the University of Sydney, Australia. This medal, founded by the Hispanic Society of America and awarded by the American Geographical Society, is given "for scientific achievement in the field of geography of the southern hemisphere."

The contributions which Dr. Taylor has made to Australian geography are distinguished by breadth of scope and originality of thought. In brilliant and versatile fashion he has applied the results of his physiographic and climatic studies to problems of settlement and human adaptation. The Australian continent offers a specially favorable field for such studies, many of which have an immediate practical bearing. Such, for instance, is the case with Dr. Taylor's survey of the territory set apart for the Federal District of the Australian Commonwealth (Canberra). The more important of Dr. Taylor's writings on Australian geography include: Australia and Its Physiographic and Economic Aspects (1911; third revised edition, 1921); A Geography of Australasia (1914); The Physiography of the Proposed Federal Territory of Canberra, *Commonwealth Bur. of Meteorol. Bull. No. 6*, 1910; A Physiographic Study of the Foundation of Canberra, Australia, *Geogr. Journ.*, Vol. 43, 1914; Initial Investigations in the Upper Air of Australia, *Commonwealth Bur. of Meteorol. Bull. No. 13*, 1916; The Control of Settlement by Humidity and Temperature, *Commonwealth Bur. of Meteorol. Bull. No. 14*, 1916; Geographical Factors Controlling the Settlement of Tropical Australia, *Queensland Geogr. Journ.*, No. 18–19, 1918, reprinted in abridged and revised form in the *Geogr. Rev.*, Vol. 8, 1919; The Australian Environment, Especially as Controlled by Rainfall, *Commonwealth of Australia Advisory Council of Science and Industry Memoir 1*, 1918; The Physiographic Control of Australian Exploration, *Geogr. Journ.*, Vol. 53, 1919; Air Routes to Australia, *Geogr. Rev.*, Vol. 7, 1919; Economics of Australia, 1920; Australian Meteorology, 1920; Agricultural Meteorology of Australia, *Quart. Journ. Royal Meteorol. Soc.*, London, Vol. 46, 1920.

Dr. Taylor has also added polar exploration to his other activities. He was senior geologist and leader of the western parties on the British Antarctic Expedition of 1910–1913 (Scott's last expedition), on which expedition he has written "With Scott: The Silver Lining" (1915).

The occasion of this award of the David Livingstone Centenary Medal is particularly felicitous. The Second Pan-Pacific Science Congress will meet in August and September of this year in Australia, at which time presentation of the medal to Dr. Taylor will be made by the American Geographical Society's representative.

Publication of "The Vegetation and Soils of Africa." "The Vegetation and Soils of Africa," by H. L. Shantz and C. F. Marbut, *American Geographical Society Research Series No. 13*, published jointly with the National Research Council, is now ready for distribution (for prices and bibliographical details see the list of the Society's Publications).

The work comprises a volume of text and a case of separate maps in color. Treatment throughout has had a practical objective in view—the rational utilization of Africa's resources. The classification of vegetation is based on vegetational formations. This division, employing natural units of ecological significance, readily forms the basis for a division of the country into natural regions of plant growth, of use in the development of agriculture and forestry. Twenty-one formations are distinguished as follows: Mangrove forest, tropical rain forest, temperate rain forest, oak-conifer forest, dry forest, thorn forest, temperate brush, oases, high grass-low tree savana, acacia-tall grass savana, tall grass, acacia-desert grass savana, desert grass, mountain grass, alpine meadow, dwarf palm-temperate grass, marsh grass, desert shrub-desert grass, desert shrub, salt desert shrub, desert. All are distinguished on the map except "desert grass" which is difficult to differentiate on account of lack of data. The scale of the vegetation map is 1:10,000,000. Each formation is discussed in the text as regards botanical description, distribution, climatic conditions, soil conditions, natural production, agriculture, crop potentialities.

Inset in the vegetation map is a soils map on the scale of 1:25,000,000. Sixteen soil types are distinguished. This differentiation is based upon samples collected by Dr. Shantz on his trip from the Cape to Cairo in 1919–1920 and on more or less definite information in the literature of some regions and elsewhere by deduction and comparison. Chapters in the text deal respectively with the soils of temperate and subtropical Africa, arid Africa, tropical Africa.

The land classification map on a scale of 1:10,000,000 is based on the vegetation and soils maps. It shows agricultural potentiality and for what types of utilization each area is suited and the degree of potential productivity within each type. A full explanation of the 23 graded types thus arrived at is given in the text.

The rainfall map on the scale 1:25,000,000 is compiled by J. B. Kincer, of the United States Weather Bureau. It is based on records of 757 stations, and, while similar in its broad features, it presents a more advanced picture than its predecessors.

Mr. Ogilvie's Appointment to the Chair of Geography at Edinburgh. Mr. Alan G. Ogilvie has been appointed Lecturer in Geography at the University of Edinburgh and will take charge of the Department of Geography there on October 1. He will leave the staff of the Society on July 14 after having served nearly three years as Chief of the Hispanic-American Division which was organized in 1920 to initiate certain research work particularly on the Millionth Map of Hispanic America. During the period of his service Mr. Ogilvie has advanced a number of enterprises which the Society has in hand, and as evidence there has already appeared the La Paz sheet of the Millionth Map, in addition to the completion of four sheets and the partial compilation of a score of others. The three-sheet base map of Hispanic America on the scale of 1:6,000,000 has also been produced, and a book by Mr. Ogilvie entitled "Geography of the Central Andes" which was awarded the Milne-Edwards Silver Medal of the Geographical Society of Paris. Material progress has been made on other aspects of the program which will be announced at a later time.

When the Society invited Mr. Ogilvie to come to the United States it was understood that he would wish to return eventually if a favorable opportunity were presented for him to participate in the upbuilding of the institutions of his own country. The Society is fortunate in having persuaded him to extend his stay for a year longer than was first contemplated. It cannot better praise his work than to point directly to the work itself, which is of the highest grade of scholarship. In addition, we have found Mr. Ogilvie a friendly and loyal comrade in the general work of the Society. He has lectured before the Council and Fellows of the Society on his work in Macedonia, collaborated in the preparation of notes and articles for the *Geographical Review*, and, outside the Hispanic-American program, has supervised the preparation of a new map of Alaska on the scale of 1:1,250,000, which the Society prepared for the Alaska Road Commission. More than that, he has entered heartily into the spirit of the whole work of the institution at all times. His advice and counsel have been invaluable on many occasions.

It is one of the aims of the Society to maintain the most cordial relations with all other geographical societies, institutions of research in allied fields, departments of geography, and the like. It is therefore a pleasure to think that through Mr. Ogilvie there will be a continuing bond between the Society and the Department of Geography at the University of Edinburgh in the advancement of geographical science.

The Society has appointed Mr. Ogilvie a Research Associate and will continue to have the benefit of his counsel in carrying forward its program of research in the Hispanic-American field.

GEOGRAPHICAL RECORD

NORTH AMERICA

Remarking of the Initial Point for Surveys and Maps in North America. The recent remarking of the Meades Ranch Station calls attention to the unique importance of this triangulation point. It was in 1901 that Meades Ranch in Kansas was selected as the initial or standard point for all triangulation computation in the United States. The station is one of those forming the transcontinental arc of triangulation and the triangulation along the 98th meridian and therefore is near the center of the area of this country. The geographical position is latitude 39° 13′ 26.686″ N. and longitude 98° 32′ 30.506″ W. These data, together with the azimuth of the line from station Meades Ranch to station Waldo, and also the dimensions of the earth as derived from the Clarke spheroid constitute what was first designated as the United States Standard Datum but later, when adopted also by Canada and Mexico, as the North American Datum.

The original marking of the station Meades Ranch in 1891 consisted of an underground mark, which was a bottle filled with ashes and buried about three feet deep, and a surface mark in the form of a marble post six inches square and two or three feet long placed with the top flush with the ground. On the top were cut the letters U. S. C. S. and two grooves at right angles. The intersection of the grooves indicated the center of the station. In 1922 J. S. Bilby, an engineer of the United States Coast and Geodetic Survey, replaced the old marking by one that was more substantial. The description of the present marking is as follows: "The underground mark is an inscribed metal tablet 34 inches below the surface set in a block of concrete 18 inches square by 4 inches in vertical thickness. The surface mark is a similar tablet set in the top of the center of a block of concrete 36 inches square at the base, 24 inches square on top, and 3 feet in vertical height. It projects 6 inches above the surface of the ground. Two inches of sand separate the two blocks of concrete. The name of the station and the date of establishment are stamped on the tablet. The station Meades Ranch is 12 miles north of the town of Lucas, Kansas."

It was due to the efforts and vision of the former head of the United States Coast and Geodetic Survey, Dr. O. H. Tittmann, and the former Chief of the Division of Geodesy of that Survey, Professor John F. Hayford, that an initial station was adopted for the whole of the United States. Through the influence of the late Dr. W. F. King, Director of the Dominion Astronomical Observatory, Canada adopted the same datum as that used by the United States; and in Mexico similar action was taken through the efforts of Dr. Pedro C. Sanchez, Director of the Mexican Geodetic Commission, and his associate, Professor Aurelio Leyva.

North America is the only continent that has a single initial point for its triangulation and mapping system. This is an ideal which geographers and other scientists of the world wish to see established in each of the continents. It is probable that within the coming generation this ideal will be accomplished through the efforts of the Section of Geodesy of the International Geodetic and Geophysical Union, which has representatives from many nations.

W. Bowie

SOUTH AMERICA

A New Map of Brazil on the Millionth Scale. The Club de Engenharia of Rio de Janeiro has signalized the centenary of Brazilian Independence by a notable advancement of the International Map of the World. The plan of the Club, which was announced in 1916 and undertaken in commemoration of the anniversary with the co-operation of the Federal and State Governments, comprises nothing less than the publication of the fifty-two sheets, in whole or part Brazilian, of the Carte International du Monde or International Map of the World on the scale 1:1,000,000. Thirty-one of the sheets have now been published simultaneously and have been received by the Society through the courtesy of Dr. Francisco Bhering, who is responsible for the production of the map. They cover the Amazon River

and all Brazilian territory north of it, as well as all the coastal zone, save that the Rio de Janeiro sheet is still unpublished, while the latter sheet forms the most important gap in a group of ten sheets south of 16° S. now issued. There are also three sheets to include the

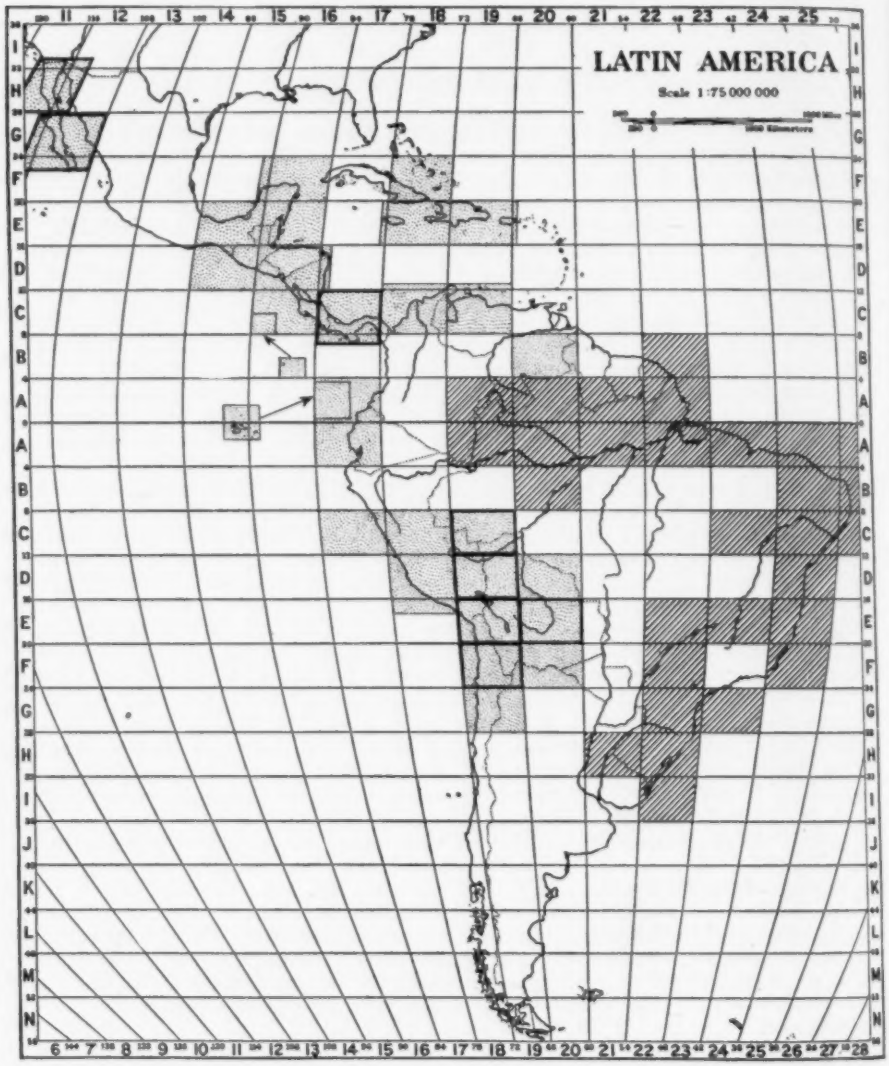

FIG. 1—Index to the sheets of the Millionth Map in Hispanic America and Brazil, indicating by a ruling the sheets (pertaining to the International Map) published by the Club de Engenharia do Rio de Janeiro, with the exception of three island sheets (N.A.–25, S.A.–25, S.F.–26). The stipple indicates sheets of the American Geographical Society's series now in hand. The sheets of this series which are in process of fair drawing or already printed are enclosed by thick lines.

oceanic islands. Thus we have for the first time a map of about half of Brazil on a reasonably large scale and showing physical as well as cultural features.

This is not the place in which to discuss the cartography in detail. It will be sufficient to state that all of the new sheets are termed "Provisional Editions." They are attractive, well drawn, and well printed. They conform in extent, in general appearance, and in many

details to the recommendations of the International Map Conference, although there are important departures which will doubtless disappear when the regular edition is published. The American Geographical Society is interested in promoting, through the various governments concerned and through its own work, the early completion of the Millionth Map of Hispanic America and Brazil and therefore looks forward with keen expectation to the publication in full of this provisional series. To have produced thirty-one sheets in so short a space is a great achievement, which brings credit to Dr. Bhering and all concerned. It would be an event of the first importance to Hispanic-American geography if similar results could be brought about in other countries, especially Mexico, Chile, and Argentina.

EUROPE

Physical Obstacles to the Development of the Danube as a Waterway. For 400 years during Roman rule the Danube was an important artery of commerce. Many vestiges along the banks bear witness to this ancient utilization of the river—traces of a channel excavated in the reef of the Iron Gate and other devices to help the navigator in that difficult section; the remains of the bridge at Turnu Severin and the admirable road of Trajan; remains of commercial stations in the present Rumanian reaches. Traffic on the river again flourished exceedingly during the preëminence of Genoa and Venice. Compared with classical and medieval times the relative position of the Danube today is greatly inferior and far below what might be expected in view of its length and volume, its latitudinal course through the great mountain barriers of Europe, and the populous character of the bordering states. It is difficult to secure figures for comparison, for along the Danube there is no consistent method of keeping records. According to figures published by the Danube Conference at Budapest in 1921 the traffic for 1912 amounted to under 14,000,000 metric tons. (It was distributed between the several reaches thus: Bavarian, 433,636; Austrian, 2,590,000; Hungarian, 5,093,000; Rumanian, 5,183,668; Bulgarian, 612,000.) Probably these figures represent a considerable amount of overlapping. On the Berlin canal system in the same year traffic amounted to 18,500,000 tons; on the Elbe system, 25,700,000 tons; on the Rhine system, 75,000,000.

Many causes have contributed to the retarded development of the Danube, political and economic as well as geographical. It is particularly the last that are considered by Hilda Ormsby in a paper read at the 1922 meeting of the British Association and published in the April number of the *Scottish Geographical Magazine*. In its upper course as far as Ulm, usually considered the head of navigation, the Danube flows through a deeply entrenched valley too big for the stream. During late summer, autumn, and winter navigation is impeded by low water. Ice is another obstacle, the more obnoxious because it often begins when grain trade is at its height in November. At least half the traffic goes off the river during winter.

Swiftness of the current also presents a difficulty, as, for instance, where the river flows along the edge of the Bohemian massif. More important is the obstacle of the Carpathians where the river flows through a defile about 140 kilometers long. This stretch, usually known as the "Iron Gates," includes the cataract sections of the gorges of Klissura and the Iron Gate proper. The Iron Gate proper is the great reef of rock that formerly stretched almost across the valley just below Orshova and through which a channel was blasted in 1896. In addition to swiftness of current, average depth in the low-water season is so low as to be critical. In the autumn of 1920 all navigation here was suspended. When the wind "Kosova" blows up the defile, the water in the cataracts may be lowered 30 centimeters.

Except for the Carpathian section there would probably be no difficulty in maintaining a 3-meter channel in the Danube from the mouth at Sulina upstream to Vienna or certainly to Bratislava. Many projects have been and are under consideration to overcome the obstacle by canalization or by deepening of the present channel, but it presents a formidable task (see for instance Antonin Smrček: Les cataractes du Danube et la navigation, *Le Danube International*, Vol. 2, 1921, No. 4, pp. 12–14; No. 5, pp. 10–15; No. 6, pp. 12–16). As it is it takes on an average three times as long to come upstream as it does to go down.

There remains another geographical factor less susceptible of transformation. The Danube flows eastward from industrial regions to regions still almost entirely agricultural. Manufactured goods of small bulk have the advantage of the downstream direction; heavy bulk goods have to move up against the current, and the cost is great in fuel as well as time.

Nor will this be altered by the opening of the projected Rhine-Main-Danube canal. In the article on Rumania elsewhere in this number of the *Review*, comment has been made on the surprising amount of trade between Rumania and other Danubian countries carried on the rail. All the Danubian ports have important rail connections and are rail distributing centers. Furthermore, there is the competition of the sea route. Before the war it was cheaper to send Rumanian wheat to Bavaria via Hamburg, for the British carriers brought with them bulk cargoes of British coal as well as manufactured goods to exchange against the grain.

In connection with this comment on the Danube as a waterway, reference may be made to the helpful large scale map (1:125,000) of the river, "Karte der Donau von Ulm bis zur Mündung," published by the Erste Donau-Dampschiffahrts-Gesellschaft, Vienna. It gives profiles of the river and among other features shows railroad connections, bridges, steamship stations, winter harbors.

The "Warm Island" of Upper Alsace. Weather records, flora, and fauna indicate the existence of a "warm island" in Upper Alsace centered around Colmar (Albert Knörzer: Die Wärmeinsel am Ostfusse der Vogesen, *Forsch. zur Deutsch. Landes- und Volkskunde*. Vol. 22, 1922, Stuttgart, pp. 249–277). A comparison of the monthly and yearly mean temperatures of Colmar with those of Strasbourg to the north and Mulhouse to the south, at either end of the Rhine garben, shows that Colmar is distinctly warmer than either. The same difference appears especially between Colmar and Strasbourg when the values are reduced to sea level. The cause of this excess appears to be the Vosges föhn, a west or southwest wind, dynamically warmed and dried by passing over the mountains and particularly pronounced at Colmar on account of the local topography. Colmar is the warmest meteorological station north of the Alps. To reach spring and summer means similar to those of Colmar, one must go south as far as Lyons or cross the Alps to Lugano.

From more southerly places Colmar is, however, distinguished by the occurrence during the winter of sudden cold snaps of brief duration. The surrounding mountains are comparatively high, and the valley is narrow, so that Colmar lies as within a big kettle. Under certain conditions this circumstance which favors the high summer temperatures causes the accumulation of a sea of cold air. Apart from these cold snaps the winters are mild. The average number of "winter (ice) days" (maximum not above 0° C.) is 16, of "summer (hot) days" (maximum above 25° C.) is 49. It may be noted that the warm island is also a dry island. It has the least cloudiness in Alsace-Lorraine.

In the warm island grape vines grow luxuriantly, and peaches, prunes, plums, almonds, and apricots abound. Such a southern tree as the cypress will grow in protected spots. Southern species do best on the hills slightly above Colmar where they are safe from the sharp temperature inversions of the valley floor. So destructive are these untimely spring frosts that bugle signals at night are employed to warn the town that frost is imminent and that smudge fires should be started. The wild plants, as well as those in cultivation, lend a southern aspect to the vegetation; many insect species here reach their northern limits, beautiful southern butterflies and beetles suggest the Mediterranean. Most of the donkeys of Alsace-Lorraine are concentrated here, so that even the beast of burden is typical of the south. The warm island, indeed, presents a charming miniature of a southern land transplanted into more northern surroundings.

ELEANOR S. BROOKS

The Morphological Regions of Bohemia and the Site of Prague. Dr. Julie Moscheles, of the German University in Prague, has prepared an excellent article on the morphological regions of the Bohemian upland (Les régions morphologiques du massif bohémien, *Ann. de Géogr.*, Vol. 32, 1923, pp. 41–57), in which a broad knowledge of her country is shown by the clearness given to the explanatory physiographic descriptions of its different subdivisions. The leading feature of the greater part of the country is a peneplain, worn down on crystalline and deformed stratified rocks and now variously warped, uplifted, and broken, so that it has at present unlike aspects and exhibits divers stages of dissection in different areas. One of the most significant items about the peneplain is that its southeastern part still possesses an even surface, smoothed down to a marine platform by the waves of an epicontinental sea before regional uplift took place; and the division between the smoothly abraded platform and the non-abraded, rolling peneplain is still marked by a line of weathered cliffs. The southern border of the platform is defined by a flexure,

where it pitches down to lower ground toward the Danube. Among the occasional accounts of ontographic features the site of Prague may be mentioned: To the south several converging branches of a main, north-flowing river, the Moldau, which in their headwaters still flow in the broadly open and shallow valleys of the uplifted peneplain, are sunk in narrow young valleys below the upland surface farther down stream and thus divide it into contiguous areas that converge in their pointed northern ends toward the district where the river branches makes their junction. The narrow valleys being inconvenient for road location, the long established highways are laid on the undulating upland, and therefore they also, like the rivers, converge northward toward the upland points. In that district a belt of relatively weak strata, infolded into the crystalline mass with northeast-southwest trends, is now broadly excavated in a new lowland below the upland peneplain; and in crossing this lowland the Moldau divides into several arms, where fording is practicable. There Prague was naturally established, as if at the apex of a fan of roads running together from all southern Bohemia.

W. M. DAVIS

The Site of Toledo, Spain. Juan Carandell's "Topografía comparada de cuatro localidades ribereñas españolas: Toledo, Montoro (Córdoba), Arcos de la Frontera (Cádiz), y Castro del Río (Córdoba)" (*Bol. Real Soc. Española de Hist. Nat.*, Vol. 22, Madrid, 1923, pp. 440–452) illustrates superposition of streams on buried landscapes with four admirable Spanish examples which American readers will find new and interesting.

Carandell makes his examples lead up to Toledo, as is natural in Spain where "every schoolboy" knows the external facts of that city's romantic site. A few words on those facts may be in place. East and west of Toledo the Tagus winds its lovely *vega* of richly cultivated alluvium through the open Tertiary plain of New Castile. At this one point the river takes a sudden half turn southward into the hills that border the plain and quickly back again, enclosing within its rather open meander ground enough for the fortress city of the Visigoths. The result is a spectacular city site. Toledo "stands majestic on its hills, with its long lines of palaces and convents terraced around the rocky slope, and on the height the soaring steeples of a swarm of churches piercing the blue, and the huge cube of the Alcázar crowning the topmost crest and dominating the scene. The magnificent zigzag road which leads up the steep hillside from the bridge of Alcántara gives an indefinable impression, as of the lordly ramp of some fortress of impossible extent" (John Hay: Castilian Days, Boston, 1880, p. 184).

The horseshoe of the river into the mountains is in a gorge in granite. The mystery of Toledo that Carandell sets himself to solve is why the Tagus left its open plain of easily eroded Tertiary rocks to plunge into the granites and carve this gorge. The answer in the Davidian explanatory style is that the river here has an incised course superimposed on the resistant granites from Tertiary beds that once overlay but have here disappeared in the mature dissection of the plain as a consequence of uplift. Three explanations cited refer to an "old channel" which the river has reoccupied, but which is left unexplained. These Carandell criticizes acutely and supports his own explanation with excellent block diagrams. Corroboration of the explanation is found in the behavior of the Guadalquivir as it flows westward along the foot of the great fault separating the Sierra Morena on the south from the *campiñas* of Córdoba and Jaen, ever and again swinging against the old rocks and incising its channel partly or wholly into them. So also at Arcos de la Frontera on the Guadalete, not far from Cadiz. In this case the river has not cut through the Tertiaries to the hard rocks lying unconformably below. All of these are craggy city sites within meanders of streams which have abandoned open plains to make brief excursions into hills.

It is gratifying to see the increasing attention given in Spain to modern aspects of geography. It is interesting to meet peneplain under the form *penillanura*. It is a great satisfaction to have the romantic city of Visigoths, Moors, and Spaniards set on a solid physiographic foundation.

MARK JEFFERSON

Influence of Geographical Factors on English Agriculture. In his presidential address to the Geographical Association of Great Britain, printed in the Spring number of the *Geographical Teacher*, Sir John Russell gave an interesting résumé of the ancient and modern agricultural systems of England in relation to geographical factors.

Under the old system, which may be said to have obtained until the end of the eighteenth century, i.e. until the beginning of improved transportation, a simple uniform scheme of food production prevailed throughout the country. Each region had to produce bread, beer, and meat sufficient for its own consumption. Mixed farming was the result, the only important exception being the sheep farming which raised wool for export. At the same time differences in rainfall, soil, and temperature caused differences in the crop grown for bread (oats and beans replaced wheat and barley in difficult regions), the animals reared (sheep in regions too poor or dry for cattle), and the general prosperity. On the western hill slopes the risk of failure owing to a wet summer was greater, and crop failure in early days meant famine. The yield was greater and the risk less in the east where prosperity meant leisure and advance in culture. "In many parts of the country the rainfall map gives the key to the distribution of monasteries, abbeys, and wonderful churches—the signs of wealth (mainly agricultural) in medieval times—and to the magnificent Jacobean and Georgian residences which indicate the agricultural wealth of later days." The effect of soil differences in conjunction with rainfall is also marked. The heavy intractable clay soils of the Weald were betrayed in the general poverty of the region—parishes were large, roads notoriously bad, the inhabitants backward.

Little of the ancient system of agricultural uniformity survives today. Money crops are grown where possible, and everywhere specialization is increasing. Speaking generally, rainfall is the determining factor in the general distribution of specialization. A north-south line running through Durham to Southampton divides the west, which has a rainfall of over 30 inches a year, from the drier east. As a general rule the east is the crop-growing area, the center combines crop growing with dairy farming, while the wetter hilly west is given over to stock raising, pasturing, and fruit growing. Temperature is the chief control over the important specializations in early produce—vegetables, fruit, and flowers. Local conditions of relief and soil further influence the nature of the specialization. Proximity of large urban centers is a great stimulus to such development. Even in early days the presence of centers of civilization must have encouraged a certain degree of specialization. "Kent, always the highroad of continental culture, has grown fruit from very early days."

Seasonal specializations have arisen in the animal industries. Bullocks are reared in the hills of the west or north, sent to the Midlands or good grasslands of the west to be fattened for autumn killing, or, if not ready then, sent farther east to be fodder-fed for winter killing. The sheep industry has also been revolutionized, in the South Downs for instance, where by winter feeding on neighboring farms the number of sheep per thousand acres that can be produced from the chalk hills is increased three-fold.

E. M. SANDERS

AFRICA

House Types in the Cameroons. A contribution towards the literature of the house type as a geographical fact is made by Mr. L. W. G. Malcolm in his article "Huts and Villages in the Cameroon, West Africa" appearing in the January number of the *Scottish Geographical Magazine*. The West African countries afford good ground for such a study. The well-defined vegetational zones offer, in north-to-south cross section, environments ranging from heavy tropical forest to desert or semidesert, and there is a corresponding range of civilizations. In each the hut type is characteristic.

The tribes of the forest area, mainly of Bantu origin, build a long, low, right-angled hut with a gable roof. The frame is of timber or strips of raffia palm, the walls are of woven mats, strips of bark, or mudded; the roof is thatched with palm leaves or bark. The huts are joined end-on to form the village unit with the road running between two facing rows. "In some of the villages in the Cameroon the double line of huts, with the road running between, extends well over a mile in length."

The boundary between forest and grassland is sharply defined in the Cameroons; hut types, however, exhibit some transitional forms from the forest type to the characteristic grassland hut of the Sudan negro. This latter is round in plan and has a conical roof. The walls are of matting, woven strips of raffia palm, or mudded; the roof is generally thatched with grass. Separate huts form a number of dissociated compounds which radiate in all directions from the chief's compound.

Certain tribes of the Logone River, in the Lake Chad drainage basin, build conical huts of mud thirty feet high. As one approaches the arid zone on the borders of which lies Lake Chad the use of mud as a building material becomes more prevalent. As Vidal de la Blache has remarked, "C'est en Afrique qu'on peut le mieux suivre, avec l'appauvrissement graduel de la végétation l'emploi de plus en plus exclusif de la terre pour les constructions." About Lake Chad the principal dwelling is of mud, right-angled and with a flat roof, a Saharan type.

Avifaunal Regions of Africa in Relation to Vegetation. The present-day distribution of bird life in Africa may be interpreted largely on the basis of the vegetation. The most important control over the vegetation of the continent is rainfall; hence there are close resemblances between the avifaunal and rainfall maps. A map of the avifaunal regions prepared by James P. Chapin, of the American Museum of Natural History, is discussed by him in the paper "Ecological Aspects of Bird Distribution in Tropical Africa" (*The American Naturalist*, Vol. 57, 1923, pp. 106–125). For the rainfall map reference should be made to that accompanying Shantz and Marbut's "The Vegetation and Soils of Africa" (*Amer. Geogr. Soc. Research Ser. No. 13*, 1923). Excluding Africa north of the Sahara, which belongs to the Palearctic Region, the following major subdivisions are recognized for the remainder of the continent (Ethiopian Region). I, West African Subregion: A, Guinean Forest Province; B, Guinean Savana Province. II, East and South African Subregion: C, Humid Montane Province; D, Sudanese Province; E, Northeast African Province; F, Eastern and Southern Province. (Mr. Chapin carries his division to 17 minor districts. Compare the note "The Faunal Regions of Africa, Based on the Distribution of Fishes," *Geogr. Rev.*, Vol. 6, 1918, pp. 371–372.)

Nearly the whole of Africa lies between the annual isotherms of 20° C., often taken as the limits of the tropical zone. Within this the effects of temperature alone are important only at altitudes exceeding 5000 feet, where the subtropical zone begins. The altitudinal temperate zone, beginning at 10,000 feet on the equatorial peaks, is very limited in area and plays an insignificant part in African bird distribution in contrast with the rôle of this zone in tropical South America. Similarly, as one proceeds north and south of the equator, the latitudinal factor has weight as it affects precipitation rather than temperature.

Rainfall is the basis of the prime subdivision. The West African subregion is the principal area, with a rainfall of over 60 inches. Within this division seasonal distribution of the rains is important. Thus a rainfall of 150 inches in Sierra Leone is insufficient for a continuous forest cover because of the four-months' dry season; on the other hand in the Upper Congo places with scarcely 65 inches of rain are clothed with superb unbroken forest. The equatorial forest belt is characterized by extreme scarcity of grasses, and its borders constitute a sharp line of faunal demarcation. It forms the southern limit of many species. In the east, where the forest barrier breaks down, species find their way far south. Some migrants, however, boldly cross the forest where they may be seen regularly in the clearings. Migrations of African birds also show the influence of rainfall. Migrations are not, of course, on the scale of those of the cooler zones, and the small birds of the equatorial regions are very sedentary; but north and south of the equatorial belt, where the effects of an annual dry season are felt, seasonal movement takes place. Many birds move from the drier Sudan, for instance, southwards to the savanas on the edge of the Congo forest, a journey of some few hundred miles. Some cross the equatorial belt, as we have said, or go round it, to take advantage of reversed seasons on the opposite side of the line.

In South Africa the boundary between the avifaunal districts (Southeastern Veld and Southwestern Arid District) runs north and south in sympathy with the rainfall. For similar reasons north of the equatorial belt the divisions run east and west. Even in East Africa, where the effects of topography are most marked, it is largely the way in which rainfall is involved that matters.

The Climate of Southwest Africa. The cold Benguella Current brings to the coast and interior of Southwest Africa climatic anomalies which are analogous to those which the Humboldt current brings to corresponding latitudes of the western coast of South America (compare R. C. Murphy's paper on the oceanography of the Peruvian littoral in the January number of the *Review*). Most interesting and important of these are the winter rains of the interior which Dr. Leo Waibel discusses in "Winterregen in Deutsch-Südwest Afrika" (Abhandl. aus dem Gebiet der Auslandskunde, Vol. 9 (Section C, Naturwissenschaften,

Vol. 4) University of Hamburg, 1922)—a study of the influence of the Benguella Current on the climate and vegetation of that part of the former German possessions located between latitude 24° and 28° S. and longitude 14° and 20° E. The discussion is based on reports from government stations and volunteer observers particularly for the year 1913–1914 but, in many cases, for much longer periods.

The northerly, offshore bearing of the current produces between current and coast a strip of ocean in which upwelling lowers the surface temperature even below that of the surface of the current itself and an average of 8° C. colder than would be expected in this latitude, while the average temperature of the coast is 5° to 6° C. colder than its latitude would indicate. Isotherms drawn here run parallel to the coast. Of two stations, Swakopmund and Lüderitzbucht, the more northerly, Swakopmund, has the lower temperatures, owing to the fact that the prevailing south to southwest winds are really the southeast trades bent landward as they pass from land to sea so that the wind at the more southerly station arrives by a shorter curve over the cold ocean than that at the more northerly. Swakopmund had an average of 15.2° C. and Lüderitzbucht 16.3° C. Also the average yearly temperature increases from the coast inland in spite of the fact that the coastal highlands rise to some 2000 meters and border an interior plateau with an average altitude of about 1200 meters. For three stations, Lüderitzbucht, Kuibis, and Keetmanshoop, extending from the coast inland in the order named, the average yearly temperatures were 16.3° C., 25° C., and 25° C., respectively. Both summer and winter the interior is warmer than the coast. The difference between the average summer temperatures of interior and coast was 12.5° C., between winter averages 5° C. Such is the difference between sea and land temperatures that, although coast and interior are blown upon by moisture-laden winds, yet, for 100 and more kilometers inland, the region is practically rainless to the north and only very sparsely watered to the south. The moisture of the landward-borne air quickly condenses over the cold Benguella Current so that fog is there almost a permanent feature. On reaching the warmer land, however, the moisture is dissipated, and the cloud masses drift far inland often rising over the coastal highlands without producing rain. At times, particularly in winter when the difference between the temperatures of coast and interior is least, precipitation occurs in the highlands and on the interior plateau in the south.

Such rains as reach the interior in summer are largely thunderstorms from the northeast. Waibel calls these summer rains even though their occurrence may extend into the winter season. By winter rains he means those rains which come to the interior by south to southwest winds from the Atlantic. Their occurrence is due to the fact that the territory under discussion backs well up against the horse latitudes so that with the northward shifting of the heat equator there comes to the southern part of this area the edge of many of the cyclonic storms by which the temperate zone is characterized.

Three distinct vegetation zones result from the various ways by which moisture reaches this region—the evergreen vegetation of the coast constantly bathed in mist and fog; the summer green vegetation of the north watered by the northeast showers; and the winter green vegetation of the south and south-central. Between these latter two occurs a zone of summer and winter green; that is a zone watered by both summer and winter rains in which the growth of vegetation has two maximums. It must be understood, however, that such expressions as evergreen, summer green and winter green are relative terms only. The region is desertic or semidesertic—at best sparsely watered.

AUSTRALASIA AND OCEANIA

The Evolution of Ocean Island. Among the fundamental problems of physical geography given a regional basis by the Pan-Pacific Scientific Conferences is that concerning the late geological history of the Pacific floor. This comprehensive problem calls for many lines of investigation, and in this connection it is interesting to note the suggestions for research made by Mr. Launcelot Owen as a result of his study of Ocean Island (Notes on the Phosphate Deposit of Ocean Island; With Remarks on the Phosphates of the Equatorial Belt of the Pacific Ocean, *Quart. Journ. Geol. Soc.*, London, Vol. 79, 1923, pp. 1–15).

Many of the Pacific islands within 10 degrees of the equator are known for their phosphate deposits. The low oceanic islands of the east, with smaller and more recently formed deposits (leached guano), were first exploited (see R. A. F. Penrose: Nature and Origin of Deposits of Phosphate of Lime, *U. S. Geol. Survey Bull. 46*, Washington, D. C., 1888). The richer islands lie between longitude 140° E. and 180° E., and those being worked

today include Angaur, Makatea (near Tahiti), Nauru (compare the note by T. J. McMahon, "Nauru: A Treasure Island of the Pacific," *Geogr. Rev.*, Vol. 11, 1921, pp. 446–448), and Ocean Island.

Ocean Island lies on the equator in longitude 169° 30′ E. It is practically circular in outline with a circumference of 6 miles and rises to a maximum height in the center of 300 feet above sea level. Vertical and much-eroded cliffs reaching as great a height as 30 feet, line the island; and it is bordered by a platform of marine erosion 100 yards wide. The base of the island is a typical fossil coral reef much altered by marine and subaerial erosion. It exhibits a series of steps or terraces at least three of which can be traced entirely round the island; they are gently tilted towards the south-southeast. Overlying this base is the phosphate deposit, averaging somewhat less than 50 feet in thickness. It consists of a completely leached guano with detrital limestone, and the underlying rock has also been changed into a phosphatic rock. The original guano, undoubtedly due primarily to bird droppings, was deposited on the slowly rising reef. There is no sign of submergence since this deposition. A slight movement of elevation seems to be in process at the present time. Geological evidence of the differential movement is confirmed in an interesting way by a study of the variation in composition of the deposit. The percentage of phosphate is found to vary regularly with depth. A series of "isophosphatic" lines can be established which are conveniently referred to a datum line of 80 per cent phosphate (tricalcium phosphate) content. On this basis the quality of the phosphate at any point of the island can be predicted. Direction of the phosphatic planes confirms the evidence of tilting. Similar study of other phosphate islands is much to be desired.

The Use of Remote Islands as Meteorological Stations. The successful functioning of the meteorological station installed on Jan Mayen Island (see the *Geogr. Rev.*, Vol. 12, 1922, p. 653) has drawn attention to this use for remote islands situated in areas critical from the standpoint of weather prediction. From the antipodes come two recent proposals for such utilization.

Captain J. K. Davis, Commonwealth Director of Navigation, spent the hurricane season, November to April, 1921–1922, investigating the possibilities on Willis Island (Willis Island Meteorological Station: Report by Captain John K. Davis, *Parliamentary Paper, No. 36*, Commonwealth of Australia, 1922). Willis Island lies in latitude 16° S., in the Coral Sea between the Queensland Coast and the Louisiades. Many storms originate near latitude 10° S. and, moving southwestward, pass over Willis Island before recurving in their parabolic path. Any extensive disturbance reaching the Queensland coast first travels over the island. (See Plate 33 in "Hurricanes and Tropical Revolving Storms," by E. V. Newnham, reviewed elsewhere in this number of the *Review*.) Willis Island itself is a mass of coral sand 468 by 150 yards in extent, surrounded by a coral beach. The climate is characteristic of tropical islets; the temperature range is very small, the evenness of the night temperatures being especially marked, and the humidity high. Establishment of a permanent station here is strongly recommended.

The case of Sunday Island in the Kermadec group is somewhat different. This island, the largest of the group, lies 600 miles northeast of Auckland, N. Z., halfway to the Tongas. It is a mountainous island of volcanic origin and covers an area of 7260 acres. In the past it was frequented by whalers, and attempts at settlement were made but abandoned largely on account of its isolation. The water supply of the island is rather scant, but the soil is productive and the climate genial. There are, in fact, distinct possibilities for its future as an agricultural settlement as well as a meteorological station (D. C. Bates: Weather Research on the Kermadec Islands, *New Zealand Journ. of Sci. and Technol.*, Vol. 5, 1922, pp. 265–274). In this latter respect the value of the island lies in its position in the path of many tropical storms which affect the weather of North Island, New Zealand, and especially the Hawkes Bay district. Furthermore, it would provide valuable data for the ocean weather forecasts that are sent out by the Meteorological Office of the Dominion from Awanui, at the extreme northern tip of North Island.

Modern Australia and Recent Studies in Australian Discovery and Exploration. To "clear away much ignorance and misunderstanding concerning Australia, the picture of whose conditions has been largely left to the doubtful artistry of traveling politicians" was a task undertaken by several of the leading economists, historians, jurists, sociologists, and educators of the southern continent in a volume published in 1920 and entitled "Australia:

Economic and Political Studies." The editor, Professor Meredith Atkinson, Head of the Department of Sociology of the University of Melbourne, supplies an introductory chapter, "The Australian Outlook," in which he interprets the Australian spirit of independence.

Other chapters deal with political systems and political consciousness, with labor and the judicial regulation of industrial conditions, with education and the women's movement, with land settlement and legislation, with Australia's relation to the Empire and to the other powers controlling the Pacific, with the "White Australia" policy, and with the distribution of private wealth. Professor Griffith Taylor's discussion of the "Physiographic Control of Settlement" is an important essay in human geography.

The writers of the volume, though they give expression to keen and assertive national pride normal in a young nation, nowhere descend to the uncritical and prejudiced utterances of the chauvinist. They are able to discern the flaws as well as the merits in the institutions of their land. If in Australia they are conscious of a greater measure of social justice than is enjoyed elsewhere, a more equitable distribution of wealth, more humane laws governing conditions of work in factory and field, a greater and possibly more salutary degree of political power in the hands of labor, they are not blind to the facts that class consciousness is more bitter; that strikes are more frequent and paralyzing; and that the more the trade unions gain, the more insistent and unreasonable become their demands. These writers feel with an intensity almost akin to crusading ardor that the preservation for the world of all that is best of British tradition and standards depends on the maintenance of a "White Australia," or a barrier against the menacing floods of color. They are not, however, unwilling to concede that Australians themselves have failed to make the most of what their own continent offers and that justification of "White Australia" will come only when the resources of that continent are developed by white hands to their full potentiality of development. Nor are they unwilling to grant that, through official and private inefficiency as well as through a widespread disinclination to shoulder the burden of a hard and lonely life in the "back-blocks" and Northern Territory, these resources are not at present being so developed.

The unity of treatment which "Australia: Economic and Social Studies" misses through diversity of authorship; and the detached point of view which it misses because it is written by dwellers in the country with which it deals, are both to be found in President C. F. Thwing's recent volume on "Human Australasia" (Macmillan, 1923). This study has the advantage which the work of a discriminating foreign traveler occasionally possesses over that of the native authority.

We learn from both of these volumes that the general level of primary and secondary education in Australia is high and that much excellent work is being done in the universities. Australian civilization is, however, peculiarly in the formative stage. The present phase of intellectual initiative is characteristically illustrated by Professor Atkinson, who observes that though "no country in the world has been more forward in social experiment . . ." none "has been more backward in contributing to the world-stream of sociological thought." In the geographical field this same spirit that so lately was engaged in pioneering now turns with especial pleasure to the investigation of those adventurous voyages and explorations, the recent forerunners and determinants of colonization and of settlement. If Australians have not contributed much to the analysis of their institutions, they have, quite characteristically, devoted themselves to the more congenial studies of the discovery of the coasts and exploration of the interior of their vast realm.

Something of the recent progress of these researches was indicated in a note in the July, 1922, number of the *Geographical Review*. Three books, however, not alluded to in that note, deserve particular mention. Two of these are concerned with the exploration of limited portions of the continent and are almost exclusively of local interest. These are Bessie Threadgill's readable monograph on "South Australian Land Exploration, 1856 to 1880" (Historical Compilations Based Upon the Study of Original Documents, No. 3), in 2 parts, text and maps, Adelaide, 1922 (in continuation of Gwenneth Williams' "South Australian Exploration to 1856," Adelaide, 1919) and R. L. Jack's "Northmost Australia: Three Centuries of Exploration, Discovery, and Adventure in and Around the Cape York Peninsula, Queensland, with a Study of the Narratives of All Explorers by Sea and Land in the Light of Modern Charting, Many Original or Hitherto Unpublished Documents, Thirty-Nine Illustrations, and Sixteen Specially Prepared Maps," 2 volumes, London, 1921. The latter, well defined by its title, is a monumental work—evidently very much a labor of love—and one which leaves little or nothing further to be done in its particular field.

The third book is one of far more general importance, a contribution not only to the history of Australian geography but one which supplies an important chapter, long missing in English, of the history of geography as a whole. This is an attractive volume by Professor G. Arnold Wood, entitled "The Discovery of Australia" (Macmillan, 1922). All deference to the arguments of the late Henry Vignaud notwithstanding, the discovery and mapping of the coasts of America should probably be regarded as an incident in the search for a westward route to the Orient. Similarly, the discovery and mapping of the coasts of Australia, until Cook swept "the cobwebs of the South Sea with the dust-broom of victorious common sense" (p. 399) may be regarded as an incident in the search for an immense southern circumpolar continent reaching far north into temperate or even tropic latitudes. In the existence of this "austral continent" many men had believed since the days of the Greeks, and the persistence of their belief, the unceasing influence which it exerted upon the growth of geographical theory, upon cartography, and upon the course of exploration until as late as the mid-eighteenth century was one of the major and most remarkable episodes in geographical history. The fundamental discussion of this subject in any language is Armand Rainaud's "Le continent austral" (Paris, 1893), but Professor Wood's volume, which owes much to Rainaud, is the first adequate treatment of it in English.

It has been well said that Australia turns its back to the rest of the world; the only genuinely hospitable coast, that which faces the immense wastes of the southern Pacific, was the last coast to be explored. Conceivably the entire course of colonial and imperial history might have been very different had the natural resources and temperate climate of southeastern Australia, Tasmania, and New Zealand become known at the time when the northern and western shores were being visited by Portuguese or Dutch. Professor Wood shows us the reasons for this critical fact in the history of the discovery of Australia, why for one hundred and fifty years the course from Samoa slightly south of west "had been deliberately declined by seaman after seaman—by Schouten, Tasman, Roggeveen—as certain to lead to great danger on the unknown coast south of New Guinea," and why the route from the west and northwest into these same waters was as studiously avoided.

Written in a light-hearted vein, full of appealing humor and human touches, "The Discovery of Australia" seems essentially sound in its broader narratives and conclusions. Certain controversial matters are treated with easy-going assurance. Despite the not always unimpeachable authority of John Fiske, we are not at all convinced that Columbus "had read a Latin translation of the book of Marco Polo" nor that "his copy, with marginal notes in his handwriting, still exists" (p. 70). Neither are bibliographical references satisfactory which omit place and date of publication and authors' Christian names and initials. But these are minor blemishes. As a whole, "The Discovery of Australia" not only agreeably tells a fascinating story but contributes materially to our understanding of difficult and obscure, but important, problems in the history of the evolution of geographical knowledge.

POLAR REGIONS

The Mineral Resources of Greenland. As in the case of so many other colonial lands the early exploration of Greenland was fostered by a belief in the existence of metals and precious stones. The earliest rumor of mineral wealth dates back to 1000 A. D. Baffin reported on certain mineral prospects in the seventeenth century. Hans Egede expressed optimistic opinion on the value of Greenland's asbestos in the early eighteenth century, from whence on several serious investigations were undertaken culminating in the series of official geological expeditions in the last fifty years. The results show a wide variety of minerals scattered over the narrow belt of habitable Greenland (43,130 square miles), rarely concentrated into commercially exploitable deposits (S. H. Ball: The Mineral Resources of Greenland, 60 pp., Copenhagen, 1922; separate from Vol. 63 of the *Meddelelser om Grønland*). There is, however, a marked exception in the cryolite of Ivigtut. This deposit has an altogether unique interest. It is one of the most northerly of the world's large mines. It is the only known locality in which the valuable aluminium ore is found in commercial quantities. Through royalties on exploitation it provides the greater part of the revenues of the self-supporting colony.

Ivigtut is in southwestern Greenland, latitude 61° N. The mine is situated in a small basin inset in the sheer walls of the fiord which rise to heights of over 1000 feet from the sea. The ore is mined in a great open cut and sorted by water; hence the mining season is limited to

seven months, April to November, during which water is available. Labor is imported from Denmark. The paternal government prohibits the employment of Eskimos save in the coal mine under its own control. Formerly two-thirds of the product was sold to America (Philadelphia), but now the greater portion goes to Copenhagen by steamers which make 15 to 20 round trips during the season.

Coal outcrops in the cliffs of Disco Island and the adjacent mainland. Much of the area here is covered with basalt flows, and the extent of the coal-bearing strata (of Upper Cretaceous and Tertiary age) inland is unknown. The government mine produced 1600 tons in 1914, about half that consumed in the colony. Copper and graphite are very widely distributed but occur in no important concentrations. Locally the rare earth minerals are abundant, but the total tonnage does not promise to be sufficient for the basis of a permanent industry. Gold, silver, lead, and garnet have also been produced for exportation. The Eskimos have long made use of soapstone, pyrites, and flint, while the native iron in Disco Island basalt has been the source of an active coastwise trade.

PHYSICAL GEOGRAPHY

Bird Distribution as a Geographical Problem. In a broadly conceived study, "Die Vogelwelt als geographisches Problem," W. R. Eckardt discusses the geographical significance of bird distribution as we find it today (*Geogr. Zeitsch.*, Vol. 28, 1922, pp. 321–339). He believes that during the greater part of the Tertiary the bulk of bird population occupied an intermediate zone between the north polar regions and the subtropical deserts. The greater humidity toward the northern border of this belt made conditions particularly desirable for insectivorous species, causing a "spring" migration for the season of reproduction. The periodical but abundant food supply in the cooler latitudes led in turn to the marked multiplication which still characterizes many temperate zone species. The overpopulation which doubtless occurred at certain optimum latitudes well to the northward led to the beginning of "overshooting" (*Überwandern*). By this is meant the phenomenon that certain populous northern species migrate across the tropics, going much farther south than other species which nest in lower latitudes, in order to find in the southern hemisphere winter quarters favorable for the support of large numbers. An interesting corollary of this is the circumstance that birds breeding in low latitudes are likely to have shorter, more rounded wings than northerly geographic races of the same species.

The glacial period was therefore not responsible for the beginning of bird migration, but it extended and profoundly modified it. During the Ice Age, for example, much of the Mediterranean region of the Old World was submerged or otherwise untenantable, and the birds breeding in the north had to lengthen their winter flights. The specialization produced in bird migration is still shown in the flight routes of many European species. Thus the primitive breeding range of the stork in Germany was cut through the middle by the intrusion of the ice on a front 300 kilometers wide. On the two sides of this line of division we have today two different breeding groups of storks, one of which migrates southward via Spain and West Africa, the other by way of Palestine and the Nile Valley. In South Africa storks from both centers mingle during the winter.

Although Eckardt concludes that the zoölogical regions of Wallace are unsatisfactory when applied to avian distribution, he uses the well-known terminology for convenience. The great Palearctic region is ornithologically the poorest in the earth in proportion to its area, having but 650 *Formenkreise* (species in the Linnaean or most comprehensive sense), or one to every 1300 square geographical miles. It has, moreover, not a single endemic family although there are several peculiar genera. The general lack of endemic groups is not surprising because the Palearctic has obviously been the center of evolution for most higher birds, which have spread thence toward the periphery of the great land areas, carrying forward the latest phases of their evolution elsewhere. The paucity of endemism in the Palearctic is also due indirectly to the glacial advance, which wiped out a large flora in Western Asia and most of Europe. Because of the deserts, east-west mountain chains, and the trough of the Mediterranean there has been no good chance since the Ice Age for a repopulation of plants from the south. There are today, therefore, from five to eight times as many kinds of trees in North America and Eastern Asia as there are in Europe. Birds are most numerous toward the eastern and western extremes of Palearctica, and it is interesting to note that eastern China, before its intensive cultivation by large human populations, was the richest extratropical portion of the globe.

The Ice Age had, of course, a notable effect upon the evolution as well as the distribution of birds. White species of many kinds undoubtedly developed then. Again, the advance of the ice probably had an influence upon the development of geographic races of varying sizes because large birds radiate relatively less heat than small. The horned owl of Europe is smaller than the Siberian form, while still smaller subspecies occur in North Africa and India. The races of the raven become larger and stronger as we progress northward, and the giant among wrens is a native of Iceland.

A significant and enlightening part of Eckardt's paper is that in which he deals with the characteristic continental faunas as related to former land connections. He maintains convincingly that Asia and America can have been linked only in the north since Mesozoic time, because otherwise the avifauna of Africa and the Neotropical region could not be so strikingly distinct as we now find it. In other words, there has been no such direct connection as a South Atlantic land bridge. The northern intercontinental path was more probably restricted to a route by way of Bering Sea than by way of Greenland. In the way of land birds, the Palearctic representation in America is at best fragmentary and is Asiatic rather than European. The great faunistic resemblance which obtained up to the Ice Age has disappeared, for Eurasia has received its influx of new bird life from Africa and India, while North America has derived its repopulation from South America. Since the Pleistocene land elevation North America has in fact received little or nothing from Palearctica. This is the explanation of the remarkable differences between the eastern and western avifaunas of the northern hemisphere and of the wealth of ancient types restricted to South America.

Much of the variety of bird life in South America, at once the richest and most isolated of all the continents, is due to highly favorable ecologic conditions, especially to the amount of rainfall and the lack of extensive interior deserts. There are many endemic families of birds which show long lineage and an extraordinary number of convergences. In a sense South America has been to birds what Australia has been to mammals; many of the aberrant or rapidly radiating South American groups remind one of the extraordinary adaptive radiation of the marsupials.

With reference to Australia, its bird fauna was derived by way of the Indo-Malayan Archipelago from Asia, and the island continent has on the whole more modern types of birds than South America. It is rather curious, however, that such old and widely distributed birds as the woodpeckers have not reached Australia. The same applies to the vultures and the true finches, but the absence of the former may be attributed to the fact that the Oriental archipelago is covered either with forest or long grass. Since the finches as a group do not furnish northern species which enter the southern hemisphere as migrants, it is not surprising that they are represented in Australia by the related weavers.

Eckardt's discussion of the physiology of birds in relation to their feeding and nesting habits and his account of the rapid dispersal of certain species, accompanied by accelerated evolution in color and voice, are stimulating though sometimes rather hypothetical. He is undoubtedly correct in assuming that the song of higher birds is by no means merely a *Minnelied* but is rather a male battle cry uttered in a strictly circumscribed family feeding and breeding area, a fact brought out forcibly in Howard's recent book on "Territory in Bird Life."

ROBERT CUSHMAN MURPHY

Meteorology and North Atlantic Ice. Quietly and without attracting any general attention the International Ice Patrol has been faithfully performing its important duty during the past ten years. This Patrol, established by an international Convention in November, 1913, the year following the *Titanic* disaster (April 14, 1912), is maintained by the U. S. Coast Guard, the expenses being divided among the signatory Powers at the Convention in proportion to the amounts of their respective ship tonnages. The work of the Ice Patrol has two aspects, as explained by Lieut. Edward H. Smith, the officer charged with the scientific responsibilities of the undertaking ("Some Meteorological Aspects of the Ice Patrol Work in the North Atlantic," *Monthly Weather Rev.*, Vol. 50, 1922, pp. 629–631). The first and most important duty is to determine the limiting lines of dangerous ice and to disseminate the information for the guidance of shipping. The second is the making of such meteorological and oceanographical observations as may aid in determining the

causes of the variations in the amount and distribution of the ice and thus lead eventually to the attainment of greater safety for life at sea.

The main source of icebergs is the glaciers on the west coast of Greenland, from about Disko northward. These bergs, on entering the Labrador Current, drift south along the east side of the Great Bank and in April, May, and June are a menace to shipping in that vicinity. A large number of factors are at work in controlling the variations in the North Atlantic ice from season to season. Among these are variations in the hydrodynamic conditions in the Arctic and the North Atlantic; seasonal changes in the general movements of the atmosphere under control of the "centers of action" over the Atlantic; and also the meteorological conditions over the northern regions during the preceding year, notably the prevailing winds over the birthplace of the bergs on the western coast of Greenland. Other factors doubtless also come into play. To investigate these various controls will require a thorough study of all available meteorological, oceanographical, and ice data for the region concerned. Unfortunately, there is a very great lack of meteorological stations functioning the year round, but such data as are available are to be studied. In connection with this investigation a year-round station on the coast of Baffin Land, e.g. at Cape Dyer, would doubtless be very valuable both as supplying much-needed meteorological data and also as making it possible to secure definite observations as to the number of bergs drifting southward. It takes about five months for a berg passing Cape Dyer to appear south of latitude 45° N. Long-range forecasting of ice conditions in the North Atlantic would probably be possible if the number of bergs and the dates of their passing Cape Dyer were known to the Ice Patrol.

R. De C. Ward

The Dayton Experiments in Fog Dispersal by Electrified Sand. Professor Wilder D. Bancroft, of Cornell University, and L. Francis Warren with the aid of the U. S. Air Service have put into practice the theory of coalescing droplets by discharging electrified sand over fogs and clouds. On February 11 an Associated Press dispatch told in detail some of the results of a year and a half of successful experiments. Fine sand sprinkled from a passing airplane is said to have precipitated clouds and fogs of various thicknesses and dimensions. Eighty pounds of sand charged nominally to 15,000 volts is said to have been adequate to disperse in ten minutes a cloud covering two square miles. The particles of electrified sand gather the cloud or fog droplets into larger drops which fall faster than the original small ones. Snow flurries and light rain are said to have occurred at times. Since the investigators are scientists, it is presumed that they have made due allowance for the normal tendency of a fog or cloud to evaporate, especially when disturbed by a passing airplane. Furthermore, in ascribing the light precipitation to the action of the sand, they must have been careful to watch other clouds not so treated.

As the Air Service was concerned merely with improving the visibility, no experiments in rain making were tried. Nevertheless, with such statements as ". . . in many of the arid regions storm clouds pass over without raining. These can undoubtedly be made to rain. . . ." (Bancroft in *Sci. Serv. News Bull.*, Feb. 19, 1923), the experimenters have led the public to believe that rain making is feasible at last. It may be so in a technical sense, but is probably not so in the popular sense. As a storm cloud is formed only by rising air, any lack of rainfall from it is not to be ascribed to smallness of drops but to the strength of the upward current, which does not let them fall to earth. Dusting such a cloud, therefore, could not precipitate it. However, suppose there were no upward wind and suppose there were no evaporation of the falling drops, according to Dr. W. J. Humphreys (in an address before the April Meeting of the American Meteorological Society) the precipitation of the entire water content of a cloud a mile thick and containing 1000 droplets per cubic inch would yield only 1/1500 of an inch of rain. Our appreciable rains occur not from the precipitation of a cloud but from the continued cooling of large masses of air passing over a region.

Charles F. Brooks

GEOGRAPHICAL NEWS

The Second Pan-Pacific Science Congress. At the Australian Meeting of the British Association for the Advancement of Science, 1914, expression was given to the need of organized study of the Pacific and its problems. Subsequent meetings and informal conferences

held by American institutions led to the first formal meeting for co-operative work on the Pacific, the "First Pan-Pacific Scientific Conference," held in Honolulu in 1920 under the auspices of the Pan-Pacific Union. (See Professor H. E. Gregory's Introduction to the Proceedings of the Conference, Special Publication of the Bernice P. Bishop Museum, 1921.) The second conference will be held in Australia in August and September of this year (1923) under the auspices of the Australian National Research Council. From August 13 to 22 the Congress will meet in Melbourne; from August 23 to September 3 in Sydney. The tentative list of subjects for papers and discussion thereon is given below.

A. *Agriculture and Veterinary Science*—Agriculture including soil problems, Climate in relation to crops, plant pathology, and plant breeding. Veterinary Science—Diseases of live stock in the Pacific Region; Methods of eradication and control.

B. *Anthropology and Ethnology*—Polynesian and Melanesian Races, Australian Aborigines, Totems, Languages, Folklore, Anatomy.

C. *Biology including Botany, Entomology, Zoölogy*—Botany—General plant distribution in the Pacific; Floras of Island Groups and of individual Islands. Entomology—Insects harmful to the planter and farmer; Rôle of insects in transmitting disease and the control of weed pests. Zoölogy—The distribution of animals; Fisheries.

D. *Geography and Oceanography*—Marine Currents, Continental Shelves, Charting in the Pacific.

E. *Geology*—Coral Reefs, Glaciation, Structure of the Pacific Region, Carboniferous and Permian Problem, Correlation of Cretaceous and Kainozoic Sediments in Pacific, Mineral Resources, Vulcanology, Geological Surveys.

F. *Hygiene and Climatology*—Mining Hygiene, Ventilation, Dust Prevention. Tropical Diseases: hookworm, malaria. Climate in its relation to human efficiency.

G. *Physics*—Including Geodesy, Geophysics, Radiotelegraphy, Seismology, Isostasy, arc of meridian in Australia, longitude by wireless, weather cycles, and weather forecasting.

Reference may also be made here to the interesting statement of problems issued by the Royal Academy of Sciences of Amsterdam through its International Circumpacific Research Committee. The Committee is also publishing a series of brochures on "The History and Present State of Scientific Research in the Dutch East Indies."

The National Research Council, the Geological Society of America, and several other American institutions are sending delegates to the Congress. The American Geographical Society will be represented by Mr. Alfred H. Brooks and Dr. Nevin M. Fenneman.

Bio-Bibliography of Alfred Grandidier. In the "Notice historique sur Alfred Grandidier," read before the French Academy of Sciences, December, 1922, Alfred Lacroix pays tribute to the memory of his distinguished colleague, who died in Paris, September, 1921, in his eighty-fifth year.

Alfred Grandidier's name is indissolubly connected with Madagascar. Since his first chance visit in 1865 to this then "unknown" spot he devoted himself with absolute singleness of purpose to elucidating our knowledge of the island, its resources, and inhabitants. To its cartography, natural history, history, ethnography he made notable contributions and inspired others to further study. After several years spent in traveling in various parts of the island, surveying and collecting, Grandidier commenced work on the monumental "Histoire physique, naturelle et politique de Madagascar," designed to occupy 60 volumes. He himself wrote the introductory volume; for the volumes on natural history he found collaborators; while his son Guillaume, now secretary of the Paris Geographical Society and editor of *La Géographie*, who follows his father's interest in Madagascar (see his article on Madagascar in the *Geogr. Rev.*, Vol. 10, 1920, pp. 197–222) was his collaborator on the ethnographical side. As a complement to this work Grandidier undertook the publication of a "Collection des ouvrages anciens concernant Madagascar."

Grandidier's work was no small contribution towards the successful incorporation of Madagascar in the French Colonial Empire, a fact that has been recognized by his grateful country.

The "Bibliographie Géographique" and Two Other Bibliographical Aids of Value to the Geographer. Geographers the world over welcomed the appearance somewhat over a year ago of the *Bibliographie Géographique*, Vol. 25–29, covering the years 1915–1919 (Armand Colin, Paris, 1921) and in April of the present year of Vol. 30–31 of the same publication covering the years 1920–1921 (Paris, 1923)—both volumes edited under the direction of Elicio Colin. These volumes are a continuation of the *Bibliographie Géographique Annuelle* (of the *Annales de Géographie*) long edited by Louis Raveneau and justly regarded since its inception in 1891 as a fundamental instrument of geographical research. The World War, however, forced suspension of publication after the volume for 1913–1914 had appeared in 1915. Though useful geographical bibliographies were published in connection with the *Rivista Geografica Italiana*, the *Geographical Journal*, and in the admirably full bibliographical section of *La Géographie*, none of these could take the place of the bibliography of the *Annales de Géographie* in comprehensiveness of scope, in convenience of arrangement, or in the critical acumen which lay behind the selection and characterization of the items included. Primarily in order that financial backing might be found for the resumption of the bibliography, the Association de Géographes Français—a French counterpart of our Association of American Geographers—was founded, and hence the two new volumes to which attention is now especially directed were not produced in connection with the *Annales* but under the auspices of the Association.

The new volumes fully maintain the high standard of the earlier numbers of the series. The selection of material has been broad but critical. In the volume for 1915–1919 there are 1931 numbered titles: in that for 1920–1921, only ten fewer. These figures, however, do not by any means represent the total number of references. These must be easily twice as many, for many of the numbered titles—normally representing the works of a single author—are followed by lettered items, and in many of the critical notes a wealth of minor citations is given. The majority of the references are to publications of societies, scientific and scholarly periodicals, government documents, and books which present the results of mature research or constructive thought. To take, for instance, the part devoted to the United States, we find that the majority of the references are to such periodicals as the *Annals of the Association of American Geographers*, the *Journal of Geology*, the *Monthly Weather Review*, the *Geographical Review*, the *Scottish Geographical Magazine*, the *Engineering News Record*, the *Annales de Géographie*, and others of equivalent scientific standing. Several pages are also given to the publications of the various departments of the United States Government, but only the publications of unquestioned geographical interest are mentioned. Out of a total of some sixty-odd major references on the United States, only ten are to books produced by commercial publishing houses. The purely popular book of personal impressions, unless it makes some genuine contribution to geographical knowledge, finds no place in the *Bibliographie Géographique*. On the other hand, language seems to have been no obstacle to the compilers, and it is somewhat tantalizing to the average, non-Slavonic-reading American geographer to see the number of works referred to in Russian and other eastern European tongues.

The scheme for the arrangement of the materials was worked out when the *Bibliographie* was begun in the early nineties, and with slight modifications it has remained the same ever since. The aim has consistently been to bring together materials which the geographer would wish to find together. There are two main parts, general and regional, each divided into carefully defined subdivisions. There is nothing complicated about it. Unlike some of the bibliographical products of German scholarship—helpful only after one has given time and study to their intricate structure—the organization of the material of the *Bibliographie Géographique* is transparently clear, simple, and logical: to be understood from a glance at the analytical table of contents at the end of each volume. Furthermore, numerous cross references both to the current and former numbers of the *Bibliographie* enable the student to trace out any subject in all its ramifications.

The signed critical comments on the various references form one of the most useful features of the *Bibliographie*. Where an individual work deserves especial praise or censure, this is given in a few well-selected words. The main value of the comments lies, however, in the fact that, brief as they are, they furnish the student with facilities for placing each work in its relation to earlier and contemporary investigations in the same field. This is done sometimes by references to important reviews of the work or to other works on the same topic, but frequently by a short discussion of the topic itself and of the contribution which the particular item under consideration has made toward its development.

In addition to the *Bibliographie Géographique*, two other recent bibliographical books of wider scope may well be brought to the attention of geographers. The first of these is Réné Maunier: Manuel Bibliographique des sciences sociales et économiques, Paris, 1920, in which are listed, often with brief comments, bibliographies dealing not only with matters of exclusively sociological and economic interest but with various geographical aspects of these subjects: materials of vital importance to the student of human geography on agriculture, industry, transportation, commerce, and colonies. The second is I. G. Mudge: New Guide to Reference Books, Chicago, 1923, based upon the third edition of the well-known "Guide to the Study and Use of Reference Books," by A. B. Kroeger. This is a volume which will go far toward enabling the geographer to make the most efficient possible use of the great libraries of this country.

GEOGRAPHICAL REVIEWS

Viscount Bryce's Last Book

James Bryce. **Memories of Travel.** xi and 300 pp. The Macmillan Co., New York, 1923. 9 x 6 inches.

Few men have been better equipped than the late Viscount Bryce to capture the *genius loci* lacking which the description of a region is of the dead body without the spirit. Few men have had a broader background of natural science or of understanding of mankind. Lord Bryce's skill in analyzing and interpreting human institutions is too well known to require comment. Suffice it to remark that the brief sketches of life found in his last book, "Memories of Travel," are fully characteristic of the deep insight into human problems so markedly manifested in "The American Commonwealth" and "Modern Democracies."

"Memories of Travel," however, is primarily important for what it reveals of another phase of Lord Bryce's almost universal interests. Few men possessed a more highly developed geographical instinct than he, or a more burning love of the forms and aspects of the land. It was this instinct, quite as much as the athletic or sporting spirit, which fed his unquenchable mountaineering ardor and gave to his published accounts of mountain climbs a value far above that of the average narrative of perilous feats among rocks and glaciers. It was also this instinct which impelled him to visit nearly every part of the world at some period in his life and to observe and record unerringly the appearance of landscape and the character of people. Some of his journeys were described in such well-known volumes as "Transcaucasia and Ararat," "Impressions of South Africa," and "South America: Observations and Impressions." It was his intention to publish another work on other journeys both on and off the beaten path. Had this been possible, we should now possess in the writings of Bryce something unique in geographical literature, a collection of studies of all the major regions of the world written from first-hand observation by an unusually gifted and competent observer.

"Memories of Travel" represents but a fragmentary portion of the greater work which Bryce contemplated, but it is, none the less, remarkable in breadth of scope. In three hundred all too short pages we are carried to the wastes of Iceland, to the crags of the Carpathian highlands, to the ruins and battle fields of Palestine "hallowed by traditions—all bathed in an atmosphere of legend and marvel," to the isles of the Southern Pacific, to the broad expanses of American scenery, and to the remote uplands of the Altai, untouched by civilization. Lord Bryce's gift of description, as revealed in all of these essays, is of that remarkable quality which makes the scenes he describes linger long in the memory almost as if the reader had himself looked upon them. This is not accomplished by any elaboration of phraseology but by a style so clear and simple and informal that one forgets the words and sees only the picture behind them. Two quotations will suffice to illustrate his power of picking out those essential elements of form and color in landscape which strike the mind but which less gifted writers often fail to discern through the confusion of detail. "Bare, undulating flats of bog or stone, traversed by foaming rivers, and backed by wild, irregular, isolated mountains, sometimes snow-covered, sometimes black and rugged—such are the general elements of an Icelandic view, and it needs all the vivid brilliance of the air, and the dignity which vast extent gives, to redeem them from dreariness and monotony" (p. 9). Or, to take a scene of entirely different character in the Pacific: "On one side the flowing purple of the sea, flowering into white when the breeze catches the wave crest, on the other the mountain spires, between the deep green of the trees, with their heads of red or yellow blossom. It is a landscape almost too perfect" (p. 223).

Americans will read with especial interest the chapter on the scenery of North America, written during the last year of Bryce's life. Though the appreciation of beauty in landscape is largely a subjective matter, it is probably true that those of us who are not too much blinded by false patriotism will feel that Lord Bryce's observations are fundamentally just. He points out that "everything in America is on a great scale" and that

"this vast scale gives a large number of places in which such beauty as rivers and mountains display can be enjoyed, but it does not necessarily make more beauty." He does not lavish praise on the grandeur of our mountains. On the contrary he asserts that the uniformity of elevation in the Rockies and Sierras "and the absence of striking forms" make these groups "less interesting to the climber or painter than might be expected from their height, while the dryness of the climate prevents accumulations of snow sufficient to feed glaciers. Few have forms sufficiently noble and peculiar to give them individuality" (pp. 230–231). On the other hand, there are no more striking passages in the entire volume than those in which the author gave expression to the deep feeling stirred within him by the brilliant autumnal colors of our eastern forests, by the sunset over the desert, and by the Grand Canyon of the Colorado. "Why this deep hole in the ground should inspire more wonder and awe than the loftiest snow mountain or the grandest waterfall I will not attempt to explain, but it does" (p. 248).

Scenery and Life in Western Europe

M. I. Newbigin. **Frequented Ways: A General Survey of the Land Forms, Climates, and Vegetation of Western Europe, Considered in Their Relation to the Life of Man; Including a Detailed Study of Some Typical Regions.** xi and 321 pp.; maps, ills., bibliogrs., index. Houghton Mifflin Co., Boston and New York, 1922. $3.50. 9 x 6 inches.

The volume deals with Western Europe, its land forms, climate, and vegetation, in relation to the life of man. The author in her preface designates her work as intended for the interested traveler, rather than the geographer in the technical sense. She hopes that "something of joy of intensive travel shines through the pages." This purpose she has attained in high degree; indeed, her wide learning and keen observation nowhere disguise her admirable and broadly human appreciation of all that she sets forth. She beguiles the traveler into classic fields where nature has done much and where man and nature have wrought on each other. Many questions are answered with keen insight; and many queries are aroused for the challenge of thought and, at least for an American student, for comparative application on the western side of the big salt water.

Europe is seen as before the war, but this marks no defect, since it was no part of the author's plan to include political units in her discussions. The fruits of European travel have by no means all been harvested, though long-distance globe trotting now seems the only worthy goal of some. Glaciers and glaciation, the fires of Vesuvius, the cold lavas of Britain, Auvergne, and the Eifel, the whole gamut of temperate climate, and the glory of young mountain folds, are all more available within twenty-four hours of London, than they are in America, Australia, or the two greater land masses of the old world. The "infinite variety of Europe" is virtually the author's theme, expounded on general geographic lines in the twelve chapters of Part I; while a selection of special and typical regions occupies Part II, Chapters XIII to XXII.

The author is inclined to put the real Europe, the Europe that "looks west," on this side of the meridian of the western end of the Black Sea and to include in it the whole Mediterranean seaboard. The basal elements of structure are explained, as determining the course of great routes to the south and as evolving in certain types of scenery.

More than by most geographers, and doubtless reflecting Dr. Newbigin's special training and interests, the floras are stressed in chapters on "The Plant and its Home," "Myrtle and Bay," "Meadow, Wood, and Pasture in the Alps," and "Moors and Heaths."

The industrial revolution, with the growth of transportation, has brought vast changes in the adjustment of products to environment. Such problems are freshly illustrated in Chapters XI and XII, in which some geographers may find their focus of interest in the entire volume.

Dr. Newbigin has put little system into her volume, and little was needed. It may be profitably read from cover to cover, and it may well be picked up in fragments. An index and discriminating references at the end of each chapter blaze the road to further study. But the apparatus of research is no menace to the general reader, whose best use is to dip and ramble in a volume which, designed for him, uses scientific facts daringly and without pedantry.

Albert Perry Brigham

Man and Nature in Central Arabia

H. St. J. B. Philby. **The Heart of Arabia: A Record of Travel & Exploration.** Vol. 1, xxiii and 386 pp.; map, ills.; Vol. 2, vii and 354 pp.; maps, ills., glossary, index. Constable & Co., Ltd., London, 1922. 9 x 6 inches.

The attention of readers of the *Geographical Review* has already been directed to Philby's explorations in Arabia in 1917–1918. In an article by D. G. Hogarth ("Some Recent Arabian Explorations," *Geogr. Rev.*, Vol. 11, 1921, pp. 334–337) there was given a succinct account of his remarkable expedition across the peninsula in the winter of 1917 and of his journey of three hundred miles southwestward from Riadh to Wadi Dawasir and back during the following summer. The outstanding results of the latter journey were also stated in an earlier note (Vol. 10, 1920, p. 347). In the present review, therefore, no attempt will be made to repeat what has already been said in these places about the more strictly geographical aspects of Philby's work.

The two volumes now under consideration contain a complete narrative of the crossing of Arabia. The account of the wanderings of 1918, however, breaks off upon Philby's return to the Wahabi capital from southern Nejd. It is a pity that circumstances did not permit the author to tell of his subsequent adventures and of the part he took in Ibn Sa'ud's campaign against Haïl.

Philby's book is the first full and satisfactory account of nature and man in a region about which, prior to his travels, Western knowledge had been of the vaguest and most confusing sort. Much of this region had never before been seen by Western eyes. Other parts, though discussed by Palgrave and possibly visited by him (Mr. Philby doubts that he visited them) were described in such misleading and contradictory terms as to be wholly incomprehensible. It is a fortunate circumstance, therefore, that Philby was endowed with keen powers of observation and a thorough knowledge of the Arabic language. It is perhaps even more fortunate that through his official position as representative of Great Britain he was received with favor by Ibn Sa'ud, the ruler of Nejd, and Al Hasa, under whose protection he traveled, and that the peaceful conditions established by Ibn Sa'ud's strong hand enabled him to traverse, unmolested, districts that would have been totally inaccessible not many years earlier. Philby made the most of his opportunities; and his book, consequently, is if anything more notable for the picture it paints of Arabian character and customs than for the new light it sheds upon the geography and topography of the Arabian peninsula. In this respect "The Heart of Arabia" can stand comparison with Doughty's all-too-little-read but none the less immortal "Travels in Arabia Deserta." But far different were the conditions of Philby's wanderings from those of his great predecessor in the tracts lying northward and westward. Where Doughty, the penniless outcast and despised "Nasrani," sought, sometimes vainly, the humble hospitality of the Bedouin, Philby was enabled to establish cordial and often familiar relations with the ameers and other local representatives of Ibn Sa'ud. Not that tense moments were lacking, as when the explorer and his party "marched in grim silence along the southern wall" of the town of Dam in Wadi Dawasir "under the sullen glare of its assembled people, knowing that the cry of a single fanatic or a madman's shot might precipitate a crisis in face of which, commanded as we were by every roof, we should have been powerless" (Vol. 2, p. 190). But such moments were rare, and for the most part events went along smoothly enough.

The extraordinary interest of the interior of Arabia lies largely in the fact that here is to be found one of the few remaining parts of the world where there still exists at the present time a strongly centralized and capably administered state virtually untouched by Western civilization. Here are no railroads, telegraphs, nor electric lights; neither is there democracy nor communism nor even the desire of such. We step back into a good old Oriental despotism ruled by the personal force of one man. The despot in the case, Ibn Sa'ud, is not only a man of iron but a personality of exceptional magnetism and a remarkably astute politician. An example of his skilful manipulation of the religious fanaticism of his realm to serve the ends of statecraft is furnished in his organization of the *Ikhwan*, or "Brothers," created only about ten years ago. This "new freemasonry" which "has in the course of the decade transformed the character of Badawin society and caused a flutter of anxiety throughout Arabia" is "nothing but a Wahabi revival in an intensified form." By the establishment of colonies of *Ikhwan* fanatically devoted to his interests in all parts of his territories Ibn Sa'ud has been able to bring peace and order

to wide tracts where formerly there reigned incessant robbery, bloodshed, and petty warfare.

How long this peace and security will last, how long the successors of Ibn Sa'ud may be able to hold together a people who, through dispersal and fragmentation in oases scattered far and wide in the midst of deserts and steppes, are incessantly played upon by the disruptive forces of nature and of inclination—these are problems that Philby assures us lay heavy on Ibn Sa'ud's mind.

It is difficult to refrain from writing at length of some of the many lesser details treated in these volumes: the comments on the Puritanical austerity of the Wahabis; the brilliant picture of the army of Ibn Sa'ud on the march, like a medieval host with myriad of fluttering banners; the description of the town of Riadh, with its severely unornamented architecture, and of other settlements and oases; the sympathetic sketches of Arab character and the multitude of human touches. An amusing account of the difficulties experienced by Philby's escort as they drew near Mecca in determining the direction of the Holy City in order that prayers might be properly oriented—a matter of vast moment in the practice of Islam—will appeal to the humor of the geographically minded. The student of geographical nomenclature will find much in the illuminating discussions of Arab usage regarding place and regional names and their adaptation to the physiographic features of the country. The descriptions of the land forms are usually clear, even though obviously not the work of a trained physiographer. Each of these points and many more besides well deserve more extended comment.

Especially noteworthy, however, are the data which Philby gathered from a native of those parts regarding the great southern desert, or Empty Quarter. Of all Europeans Philby approached the nearest to the northern border of this immense tract, probably the largest expanse of unknown land in the world outside the Antarctic continent. As frequently happens under similar circumstances, more detailed knowledge of the Empty Quarter leads Philby to believe that it is not so terribly barren as had hitherto been supposed. The tribe of Al Murra manage to eke a precarious living from its surface. These are a primitive folk, only recent adherents of Islam, who "lead a life as lean and wild as anything one can imagine." In a vast sandy tract of Khiran within their confines the Al Murra tell of a buried city frequented by *Jinns* or ghosts to be "heard of a windy night moaning piteously over the fate that has overtaken the scene of their lives. . . . It must indeed be an eerie spot, that dead city of the past far away from human ken, and may be the salty pools about it are all that is left of a great oasis of those times before the sand swept over the face of Southern Arabia."

Philby's exceptionally vivid and distinguished style is marred only by the tendency to make use of excessively long sentences. Were it not for this minor defect we should be tempted to class "The Heart of Arabia" with Doughty's "Travels in Arabia Deserta," Borrow's "Bible in Spain," and some of the writings of W. H. Hudson: among the few books that stand apart by themselves as masterpieces of English travel literature.

The Story of Long Island

R. H. Gabriel. **The Evolution of Long Island: A Story of Land and Sea.** 194 pp.; map, bibliogr., index. (Yale Hist. Publs., Miscellany IX.) Yale University Press, New Haven; Humphrey Milford, Oxford University Press, London, 1921. 9 x 6 inches.

The purpose of this essay is "to trace the development of a people as it has been affected not only by its social and economic but by its natural surroundings." In the evolution of Long Island the author sees an unfinished play—a game between two mighty forces, the ocean and the hinterland.

A brief sketch of the historical geology and physiography of Long Island lays the scene for the drama. The reader regrets a little that no physiographic map of the island is included, as for reference such a map is superior to the best description (the only illustration is an outline map on the scale 1:700,000). Given the environment, we are ready to visualize the life of the early settlers, most of them pioneer farmers who labored "only to get bread and clothing, without hopes of ever seeing a penny of monies." Interest in scientific agriculture awoke when improved transportation made Long Island feel sharply the competition of the great virgin lands of the West. This competition of the hinterland later forced the Long Island farmer to change from general farming to dairying and truck gardening.

Turning to the ocean, we follow successively the rise and decline of the whaling industry of the eastern harbors, the development of the menhaden fishery to supply cheap fertilizer, and its final concentration in the hands of a syndicate (cf. the author's "Geographic Influences in the Development of the Menhaden Fishery on the Eastern Coast of the United States," *Geogr. Rev.*, Vol. 10, 1920, pp. 91–100). Oyster fishing in Great South Bay exhibited a similar transition from the day of the bayman in an open rowboat equipped merely with long-handled rakes to the period of oyster planting and the steamer and dredge. As scallop beds will not remain stationary and so cannot be leased and controlled by large companies, scalloping in Peconic Bay is still carried out by individual fishermen.

Before the time of railroad building, turnpikes and coastwise sailing vessels competed for the carrying trade of Long Island. The isolation of the eastern villages around Peconic Bay gave them an excellent opportunity for smuggling and even piracy. They persisted in illicit trade with Boston and in evasion of duties to the despair of the governors of New York. It is worth noting that, later, Long Island for a short time afforded the easiest route between New York and Boston; indeed, the first line of the Long Island Railroad was built to connect with a ferry from Greenport to Stonington whence one might complete the journey to Boston by rail, making the entire trip from New York in "only eleven hours and a half." The great development of Long Island as a summer resort for the people of New York was advanced not only by the railroad but also by the coming of the highway, the bicycle, and the automobile. In the evolution of the island the sea has stimulated the variations, or the appearance of new vocations, and the hinterland has acted as the selective factor, determining which variations should survive.

This essay should be read by all who desire to gain from one significant example some comprehension of the typical trend of American agriculture and coast industries in the northeast. The clear and graceful style of the writer and his vivid descriptions of the farmer, fisherman, and adventurer of the past make his book an attractive and entertaining, as well as profitable, study.

ELEANOR S. BROOKS

A STUDY OF SEA INFLUENCE IN AMERICAN LIFE

S. E. MORISON. **The Maritime History of Massachusetts, 1783–1860.** xviii and 401 pp.; maps, ills., bibliogr., index. Houghton Mifflin Co., Boston and New York, 1921. $5.00. 9 x 6½ inches.

Far back in the seventeenth century, English men and women, crossing the little-known Atlantic in tiny ships, established themselves along the seaboard of the western continent—the first American frontier. For more than two centuries and a half, the British colonies and then the United States knew a frontier facing the open country that lay to the westward. But all the conditions of the first frontier were never repeated in those that followed. To be sure, it, like all the rest, was bounded on the west by untamed lands; but, on the east, instead of villages and cities and settled farms, lay the ocean. These shore-dwelling first pioneers heard alike the call of the land and the sea. Their early answers to these two influences laid the foundations for both the land life and the sea life of the American people. As time went on and the land frontier pushed westward, the sea frontier was pushed eastward and southward until it encircled the globe; and the qualities demanded of the men in the cabins of the ships were little different from those required in the cabin homes of the forest.

Then there came a time in our history when our people abandoned the sea and we became so engrossed in the building of railroads and factories that the old packets and clipper ships were all but forgotten. But now that we have reared a mighty industrial structure, we are reviving the memories of those bygone days when American ships and sailormen knew every sea lane of the great commercial oceans. Professor Samuel Eliot Morison's "Maritime History of Massachusetts, 1783–1860," is the best of the true stories of the sea that this awakened interest has brought out. It is, by all standards, a good book. Massachusetts, through every phase of whose history, save the last, "blows the east wind," is chosen for the setting. "Nature seemed to doom Massachusetts to insignificance; to support perhaps a line of poor fishing stations and hardscrabble farms, half-starved between the two hungry mouths of Hudson and St. Lawrence. Man and a rugged faith have made her what she is." Then the story is told from the first frontier beginnings to the end.

There is little philosophy in the book; the reader, for the most part, is left to draw his own conclusions. But it is full of suggestive material for the student interested in the influence of the natural environment on the development of men. And here and there are striking interpretations. Perhaps the best of these is the explanation of why the seafaring people of Massachusetts and New England were so bitterly opposed to the War of 1812 as to be seriously discussing secession in 1814. "They that do business in great waters have little in common with their land-plodding countrymen. Their native land is but a resting place between voyages; a wharf and shipyard and cottage by the sea. . . . The Union ceased to be valuable when fresh-water politicians took bread from the mouths of honest seamen." It must be admitted that there is little sympathy for the point of view of the Jeffersonian landlubber. In fact, one puts down the book with the feeling that New England Federalism, with all its fine qualities and all its austerity and aloofness, is not yet quite dead. But the part played by the sea in shaping the Federalist attitude is set forth as never before.

The book makes vivid a phase of American life which was of the greatest significance in out national life and one which seems to have passed almost completely out of our national consciousness. The language as well as the atmosphere of the sailing ship pervades the pages. The whole story is there—the trading ships, the fishing smacks, the whalers, and the episode of the California gold rush—all set off with well-chosen illustrations. There is an extensive and useful bibliography which omits, however, mention of Ralph Paine's "The Old Merchant Marine," a book which as much as this makes the old maritime spirit of New England live again. A German monograph by Hans Keiler, "American Shipping, Its History and Economic Conditions," useful though dull, has also been omitted.

One concluding note sums up much of the influence which the sea has had in shaping American life. "Never, in these United States, has the brain of man conceived or the hand of man fashioned, so perfect a thing as the clipper ship. In her the long-suppressed artistic impulse of a practical, hard-worked race burst into flower. The *Flying Cloud* was our Rheims, the *Sovereign of the Seas* our Parthenon, the *Lightning* our Amiens; but they were monuments carved from snow. For a brief moment of time they flashed their splendor around the world, then disappeared with the sudden completeness of the wild pigeon."

RALPH H. GABRIEL

THE WOOD-FORBES REPORT ON THE PHILIPPINES

Report of the Special Mission of Investigation to the Philippine Islands, *House of Representatives Doc. No. 398, 67th Congr., 2nd Sess. (Rept. of the Governor General of the Philippine Islands, January 1 to December 31, 1921)*, pp. 13–43. Washington, D. C., 1922.

This report, which is better known as the Wood-Forbes Report as published, is a very brief summary of 31 pages only. The bulk of the report—which, as far as the reviewer knows, has not been published—is contained in the voluminous "Exhibits." These contain much information of a confidential nature and are not generally accessible to the public. This survey in its entirety is perhaps the most exhaustive and searching inventory of a country and its people ever made in so short a time by another people.

The personnel of this special Mission included two of the foremost names ever connected with American Insular affairs. The chairman, Major General Leonard Wood, U. S. A., retired, now Governor General, of course needs no introduction since, besides his distinguished army record, he was said by Lord Cromer to be the only person qualified to "carry on" his own great work in Egypt, an estimate he has eminently justified in his last year and a half as a civil administrator in the Philippines. The second member of the Commission, Hon. W. Cameron Forbes, owing to his long service in the Philippines where he earned the sobriquet "The Road Builder," proved a strong collaborator. An especially able staff and a small army of co-workers, both American and Filipino, aided in the arduous work of this most intensive and extensive survey. In spite of the general disagreement with the findings of the report on the part of the leading Filipino statesmen, no one has been able to prove that it was unfair or in error.

In a short note of this kind it is impossible to call attention to more than a few outstanding results, and only those of especial interest to geographers will be noted here.

On page 20 the statement is made on the authority of Professor H. O. Beyer, it is presumed, since he was attached to the Mission and is the leading authority in ethnological matters in the Philippines, "there are eight languages in the islands, each of which is used by not less than 500,000 people, and some seventy-odd more which are used by smaller groups. Some differences between their dialects are slight enough so that people using different ones can make themselves understood, but many are so radically different that they are mutually unintelligible." These facts coupled with the lack of ready facilities for intercommunication are the chief factors tending to work against the solidarity of the people. As the report shows, these difficulties are being rapidly lessened.

The general land situation—and this of course is the foundation for any sound economic structure of a country—was found to be in a serious condition. The abolition of the Court of Land Registration was a serious mistake. Governor Wood is now taking steps to reëstablish it.

The teaching of English in the lower grades of the schools is one of the few points on which the reviewer would take issue with the report and with our whole Governmental policy. Unless several thousand American teachers could be employed over there it would seem to be sounder policy to follow the methods of the Dutch in this respect. On this point the reviewer is well aware that he is in the minority and that most Americans would agree with the Mission.

Very pertinent is it that attention is called to the deterioration in the Bureau of Science previous to the incumbency of the present director, Mr. Merrill. The Bureau was formerly the leading tropical research institution in the world and, under the able administration of the late Dr. Paul C. Freer, was in some ways America's greatest single achievement in the Far East. The deterioration noted, it should be said, was not due entirely to lack of Filipino support.

When we come to that part of the report dealing with the economic conditions of the islands we must pause for more than a passing scrutiny, for herein are disclosed some facts which have caused many of the more far-seeing leaders of the people seriously to reflect upon the advisability of immediately cutting adrift from the United States. A few of the salient facts are:

1. The advance in rate of taxation, 124 per cent, since the Filipinos were given greater control over their own government.
2. The low per capita taxation due to the United States shouldering all military and naval expenses for the defense of the islands.
3. The failure of various national business projects.
4. The costly experiments made by the Philippine National Bank.

With reference to the investments in sugar, the reviewer believes that these operations on the part of the bank will redound ultimately to the credit of the Government, and he is not in entire agreement with the report in this particular. The sugar industry, for long a very crude and primitive business, promises to be one of the greatest revenue producers and one of the most lucrative projects in the archipelago and a formidable rival of the industries of Hawaii and Cuba.

On the next to the last page of the report of the Mission, among some twelve specific conclusions, this, perhaps the most important of all, is found: "We find that the people are not organized economically or from the standpoint of national defense to maintain an independent government." This is the crux of the whole matter—if this conclusion is correct, then a reasonable postponement of the granting of complete independence is the only honorable course open to the United States.

The all-important geographic factors involved in the strategic position of the Philippines—lying, as they do, athwart the entrance to the great all-water world way from the Pacific to the Atlantic, the character of her neighbors, her not inconsiderable latent natural resources as a temptation to unscrupulous nations, and the explosive nature of the various elements in the Far Eastern situation generally have received scant mention in the report, though they may be considered in the exhibits. To the reviewer these geographic factors seem of far greater importance than the internal condition of the islands, and, while he highly respects the aspirations of the Filipino people, he would urge their native leaders to give the geographic factors the most profound thought before committing themselves hastily to a step which might be irretrievable.

WARREN D. SMITH

Life of the Glacial Period in North America

F. C. Baker. **The Life of the Pleistocene or Glacial Period.** xiv and 476 pp.; maps, diagrs., ills., bibliogr., index. *Univ. of Ill. Bull. No. 41 (Contrib. from the Museum of Nat. Hist. No. 7).* Urbana, 1920. $5. 10½ x 7 inches.

This volume is the outgrowth of a detailed study of the succession of biota found in the sediments of the bed of the glacial Lake Chicago. The results of this study are presented in two chapters, which follow a brief historical review of the records of life in this glacial lake bed. Advantage was taken of the geological evidence of changes of environment to which the animal and vegetable life was subjected, or in other words to ecological conditions; and the study illustrates the value of ecology in the interpretation of the variations in the fresh-water life here found.

The succession revealed by these studies may be summarily stated as follows:

1. The highest, or Glenwood, stage of Lake Chicago, 55–60 feet above the present level of Lake Michigan. Waters were cold, and life had not yet entered or was very sparingly represented.

2. A low-water stage, the Bowmanville, estimated to have been only 10 feet above Lake Michigan level. At this time a protected bay in the vicinity of Bowmanville, north of Chicago, carried a fauna of swamp and shallow-water forms of life with such snails as *Galba, Planorbis,* and *Physa.* The trees along the shore indicating the persistence of cold climate, embraced spruce, tamarack, fir, and arbor vitae, now found in districts considerably farther north. The cause for this low stage is suggested to be the opening of an eastward outlet past Syracuse, N. Y., at the time of Lake Wayne, of the Huron-Erie basin. This would imply a sufficient recession of the ice border to permit a passage by the Straits of Mackinac from the Michigan to the Huron basin. It also calls for an undemonstrated differential uplift of the Lake Wayne area.

3. The Calumet stage of Lake Chicago, 35–40 feet above Lake Michigan level. Above the muck beds and swamp fauna of the low-water stage a bed of sand and gravel was laid down, and there developed a large fauna of mussels of species that now inhabit our large rivers, "indicating that the bay was more open and subject to some wave action." It is suggested that these naiades were brought to this habitat by the aid of fish, in the glochidial stage, and liberated from the cysts when the fish reached this bay. This stage of Lake Chicago, it is suggested, may correlate with Lake Warren of the Huron-Erie basin, a lake which discharged into Lake Chicago through the Grand River outlet. The Tolleston stage of Lake Chicago is thought to have directly followed the Calumet stage by a lowering of the outlet through the Des Plaines valley.

4. A second low-water stage, unnamed, is characterized by the absence of the river type of naiades and a return to the fresh-water pulmonates of the swamp and shallow pond types. This is suggested to have as its correlative the Kirkfield stage of Lake Algonquin, but in the reviewer's opinion it may have begun at the time of Lake Lundy and covered the time to the uplift that brought Algonquin waters up to their full height in the southern end of the Lake Michigan basin.

5. The Hammond (or high-water stage of Lake Algonquin), 20 feet above Lake Michigan level, at Chicago. At this time a silty sand was laid down on the earlier deposits, and in this are preserved a few cyclads and gill-bearing gastropods and some fresh-water pulmonates.

6. A third low-water stage, unnamed, in which the lake bed of the prolific area north of Chicago may have become a land surface, is strikingly indicated by the presence of crawfish burrows, which are covered by succeeding lake deposits. This is thought to correlate with the opening of the North Bay outlet eastward from Georgian Bay to the Ottawa valley, in the early part of the Nipissing-Great Lakes stage.

7. The Englewood, or high-water stage of the Nipissing-Great Lakes, 12 feet above Lake Michigan level. This stage indicates a shallow bay, inhabited by a few cyclads, gill-bearing gastropods, and fresh-water pulmonates.

8. The present stage, which is a land surface with a few small ponds and swampy streamlets. The deposits and organic growths of this stage are ordinarily confined to the upper foot or two, largely classed as soil.

Having presented the results of this detailed study of the life in the bed of Lake Chicago, the author devotes a chapter to the postglacial biota of the entire Great Lakes region, beginning with the proglacial lakes in each of the lake basins. Interesting data are presented as

to the percentage of living and extinct species. Of 68 plant species and 271 animal species represented in the deposits overlying the Wisconsin drift, only 2 plant species and 29 animal species are extinct. Among the animals, the mollusks have 231 living and 7 extinct, while the insects have 3 living and 7 extinct, and the mammals have 8 living and 13 extinct species. Of the mammals the Megalonyx, peccary, extinct musk ox and bison, mastodon, two mammoths, two extinct elk, an extinct caribou, and the giant beaver lived and roamed the territory long after the ice had entirely disappeared from the Great Lakes region.

The author then attempts to bring together the available data on the remains of life found in the oldest drift and in each of the interglacial deposits, as well as that imbedded in the tills. This represents a vast amount of reading and considerable reflection. In many cases in which remains of plants or animals have been found the precise geological horizon is uncertain. The present volume, in the reviewer's opinion, is open to the criticism of giving too definite an assignment of the geological horizon in many cases. There are at least a score of places in which the reviewer is certain that the wrong geological horizon is assigned, and as many more where there is uncertainty of the correctness.

There are also a number of incorrect items of correlation and of explanation in reference to the history of some of the glacial lakes, which will make it important for the reader to consult the papers or reports cited. Thus on page 112, in discussing Lake Arkona, it is stated: "For some reason, not yet well understood, the lake waters were drawn down to a much lower level." It is really well understood that this lowering was due to the recession of the ice border from the "Thumb" of Michigan, thus allowing Lake Maumee to become confluent with Lake Saginaw and be drawn down to its level. It is also incorrectly stated that there was a similar lowering in the Michigan basin. On the same page the Ubly outlet is given as an outlet of Lake Maumee, whereas it was the outlet of Lake Whittlesey.

There are also certain ideas presented that are out of date and inconsistent with later publications. Thus the idea that Lake Erie started as a small body of water in the eastern end of the basin (p. 86) is opposed by the evidence brought out by Leverett in *U. S. Geol. Survey Monograph 41* that differential uplift only affects the eastern end of the basin. The main fluctuations in its level are due to the great changes its drainage area has sustained. It is now in a flooded state because the three upper lakes have had their drainage diverted into it by uplift of the North Bay outlet. The map of preglacial drainage in the Great Lakes region (Pl. 54), taken from J. W. Spencer, is out of date for the Huron and Michigan basins, as may be seen by reference to Plate 2 of *U. S. Geol. Survey Monograph 53*, in which it is shown that there was preglacial drainage westward from Saginaw Bay to the Lake Michigan basin.

The faults and errors pertain as a rule only to matters indirectly related to the subject under discussion and in but few cases are likely to be misleading. The volume as a whole is a painstaking and thorough piece of work.

FRANK LEVERETT

A STUDY IN REGIONAL PHYSIOGRAPHY

C. A. MALOTT. **The Physiography of Indiana.** Maps, diagrs., ills. Separate of Handbook of Indiana Geology, Part II, *Indiana Dept. of Conservation Publ. 21*, pp. 59–256. Indianapolis, 1922. 50 cents. 10 x 7 inches.

The state of Indiana comprises parts of two physiographic provinces within the great interior plains of the United States. The northern two-thirds of the state, lying within the Central Lowland Province, has been glaciated and is characterized by a belt of recent moraines and old lake beds crossing the northern quarter of the state from Lake Michigan eastward into Ohio, south of which stretches a wide belt of almost undissected till plains. This section offers no especially new or unsolved problems. In discussing it the author has drawn largely upon the writings of Dryer and Blatchley and Leverett's splendid monographs.

The northern moraine and lake region is subdivided into the following five belts: the Calumet lake section, being the old floor of Lake Michigan; the Valparaiso moraine, which rims and encloses the Lake Michigan basin; the Kankakee lake section of local till, sand, and outwash plains, lying just outside the Valparaiso moraine; followed by the Steuben interlobate moraine, formed jointly by the Saginaw and Erie lobes; finally to the east the Maumee lake section, representing the old floor of Lake Erie and bearing the

same relation to the Steuben moraine as the Calumet lake section does to the Valparaiso moraine.

The middle belt of Indiana, forming the Tipton till plain, is a constructional feature in the zone of ice wastage and owes its little relief either to the low moraines whose knolls seldom rise over 40 and never over 100 feet above the plain, or to the old glacial waterways, now broad valleys leading southward across the plain.

The southern one-third or less of the state lies within the maturely dissected Interior Low Plateau Province. In this southern portion there has been no glaciation or the deposits are thin and insignificant. This southern area is the most rugged part of the state. Erosion upon a series of strata dipping gently westward from the axis of the Cincinnati arch has produced strips of upland and lowland which emerge from beneath the glacial cover at the north and extend southward across the Ohio River into Kentucky. Three uplands are described. The deeply dissected Crawford Upland, rising gradually eastward from the wide lowland of the Wabash River, which forms the western boundary in this part of Indiana, is the most rugged physiographic division of the state. Its steep eastern face overlooks the Mitchell Plain east of which there is a second gradual rise to the summit of the Norman Upland. This is terminated on the east by the well-known Knobstone escarpment, in places over 600 feet high, overlooking the Scottsburg Lowland, only to be succeeded by a third gradually rising slope to the summit of the less rugged Dearborn Upland which forms the eastern border of Indiana and extends into Ohio and Kentucky.

This part of the state is replete with problems of interest, mainly involving the dating of the peneplains represented on the several uplands, and a correlation with the Highland Rim and other levels outside of Indiana to the east and south. Obviously, from the inconclusiveness of this part of the paper, the physiographic history of the eastern United States, of which this problem is only one phase, needs some revision. It is not impossible that a radically new and more satisfactory interpretation may be offered by some careful investigator who studies the problem in its larger aspects.

In every respect Mr. Malott presents here a very valuable document, such as should be available for every state in the country. His tendency, however, to present his facts first empirically and later to explain them, unnecessarily burdens his reader with the need of carrying along many apparently unrelated physiographic matters while waiting for the explanation which is to link them together.

A. K. Lobeck

Physical Oceanography and Its Problems

R. L. Faris. **Some Problems of the Sea.** *Journ. Washington Acad. of Sci.*, Vol. 12, 1922, pp. 117–132.

J. T. Jenkins. **A Textbook of Oceanography.** x and 206 pp.; maps, diagrs., ills., bibliogr., index. Constable & Co. Ltd., London, 1921. 9 x 6 inches.

A. Berget. **Les problèmes de l'océan.** 329 pp.; maps, diagrs., ills. (Bibliothèque de Philosophie Scientifique.) Ernest Flammarion, Paris, 1920. 6 fr. 75. 7½ x 5 inches.

J. Thoulet. **L'Océanographie.** ix and 287 pp.; diagrs. (Collection "Science et Civilisation.") Gauthier-Villars & Cie., Paris, 1922. 7½ x 5½ inches.

J. Rouch. **Manuel d'océanographie physique.** 229 pp.; maps, diagrs., ills., index. Masson & Cie., Paris, 1922. 8½ x 5½ inches.

In "Some Problems of the Sea" Captain Faris directs attention to the larger problems of oceanography—not the problems of the specialist engaged in research in some restricted field of this vast domain, but those that are fundamental to oceanography and concern the various sciences that "meet in and upon the sea": the features of the ocean floor, sedimentation, oceanic circulation, tides and tidal currents, mean sea level, terrestrial magnetism, gravity, meteorology, and ocean temperatures.

"The mariner," Captain Faris points out, "sails on a more familiar sea than the oceanographer or the geophysicist." The meagerness of our knowledge of the floor of the open sea is well brought out by the fact that for the three oceans best known to man, outside the 1000-fathom line, "in the Atlantic . . . there is now one sounding for about each 12,000 square miles; in the Pacific, one sounding for each 25,000 square miles; and in the Indian Ocean, one sounding for each 26,000 square miles." Large areas of the ocean

floor are still virgin fields for the oceanographer, there being "one region of two million square miles that has never felt a cast of the sounding line."

Our knowledge of the floor of the ocean is but typical of our knowledge of the open sea in general. Striking deficiencies exist in the matter of ocean temperatures; systematic tidal and current observations are wholly wanting, being confined to the immediate vicinity of the coast; a beginning—an excellent one, to be sure, but nevertheless a beginning—has been made in the magnetic survey of the oceans; a promising field has been opened up in the correlation between oceanographic and meteorological phenomena; much work remains to be done in the study of sea-level changes with reference to the elevation and subsidence of the coast—in fact throughout the realm of oceanography we have not yet arrived at the period of the "second decimal place."

The domain of oceanography is so large, and the expense involved in securing data is so considerable, that only in international co-operation lies the hope of results commensurate with the necessary cost. Captain Faris calls attention to this but finds encouragement in the growing recognition of the fact, as evidenced in the meetings of the Pan-Pacific Scientific Conference and in the establishment of the International Hydrographic Bureau.

Dr. Jenkins, in the preface to his "Textbook of Oceanography" calls attention to the fact that "in spite of the great interest that maritime questions have for the English-speaking nations, there is no modern textbook in English on the subject of oceanography." This need he has endeavored to fill in a work "designed to meet the requirements of the higher forms of schools, of teachers in training, and of students attending a school of geography at one of the Universities, as well as intending naval and mercantile marine officers."

The introductory chapter discusses the extent and the classification of the oceans, sea level, the hypsographical curve of the earth's surface, and the general features of the ocean floor. Chapter II deals with oceanic deposits and bottom fauna and with the permanence of the oceans. Chapter III treats of the temperature of the sea, the properties of sea water, sea ice, icebergs, atmospheric gases in sea water, and salinity. Chapter IV deals with waves and tides, and Chapter V is devoted to ocean currents.

To introduce the student to oceanography and acquaint him with the methods and results of modern oceanographic research in a book of 200 pages is no light task. One difficult problem is the extent to which the various topics are to be developed. Dr. Jenkins devotes a third of the book (Ch. V) to ocean currents—very nearly the same number of pages that are apportioned to all of the subjects discussed in Chapters I, II, and IV combined—yet under the section featured by the heading "Influence of the Coast" (p. 143) we find the following: "Marked deviations in the courses of ocean currents are produced by the obstructive influences of the coasts of the various continents and islands"—this and nothing more. In the section devoted to "The Influence of the Earth's Rotation" (p. 141) the effects on free currents and on wind-driven currents—two entirely distinct problems—are treated as if but a single problem were involved.

The chapter on tides, in particular, appears to have been done hurriedly. Under "Tidal Theories" four are named but only three described; a fifth—Whewell's progressive-wave, or Southern Ocean, theory—is introduced quite inadvertently and without being differentiated from the others. The tide predictor—the very name would appear to indicate its use in the prediction of tides—is described as a machine with which "the numerous calculations necessary in the harmonic analysis can be performed" (p. 118). Typographical errors in the formulae on pages 116 and 117 will prove confusing to the beginner. No mention is made of tide tables or the prediction of tides—surely interesting and important topics.

The bibliography is limited to publications in the English language. Under "Tides" (p. 201) only three entries appear; but G. H. Darwin's well-known book, "The Tides and Kindred Phenomena in the Solar System"—unquestionably the best non-mathematical introduction to the tides in English—is not listed. This is all the more surprising, since one of the illustrative figures (Fig. 19D) is credited to Darwin. And would it not be of advantage to call the student's attention to the standard work on oceanography—Krümmel's "Handbuch der Ozeanographie"—even though it be in a foreign language, especially when five illustrations are credited to its author?

There is great need for a textbook in English such as Dr. Jenkins had in mind, and it is to be hoped that a revised and considerably enlarged edition of his work will be forth-

coming in the near future. Opportunity will then be afforded for giving the correct spelling of "areometer" (not "aerometer," as on pp. 71, 72, and 203); for giving the correct length of the tidal day, 24 hours 50 minutes (not 24 hours 40 minutes, as on p. 109); and for including among "The Principal Ocean Deeps" (p. 22) the "Planet" sounding in the Swire Deep, which is the greatest depth so far recorded and which exceeds by 500 feet the depth given by Dr. Jenkins as the greatest.

In "Les problèmes de l'océan" Professor Berget sets out to develop in non-technical language the problems of oceanography. The first five chapters deal with the chemical and physical properties of the ocean waters, the sixth chapter with sea ice, and the three following chapters with waves, tides, and currents. Successive chapters take up the distribution of land and sea, the depths of the ocean, changes in shore line, the floor of the ocean, and a consideration of the past and the future of the ocean.

Though writing in a somewhat popular style, Professor Berget manages to cover the ground in a thorough manner. Not only in the choice of topics but also in the extent to which they are developed is a nice sense of proportion exhibited. This is especially well shown in the chapter on tides—a difficult subject and one which suffers in most oceanographies. In the 38 pages devoted to the tides, Professor Berget gives an unusually satisfactory discussion of the subject. "Les problèmes de l'océan" is in no sense a manual or a textbook, being intended not for the student but for the intelligent layman whose reading of it should give him an insight into the problems confronting oceanography and the progress made in their solution.

"L'Océanographie," by J. Thoulet, is the work of a veteran French oceanographer whose contributions to the subject extend over a considerable number of years and whose publications, especially "Océanographie (statique)" (Paris, 1890) and "L'Océan: Ses lois et ses problèmes" (Paris, 1904) are well known. For Professor Thoulet physical oceanography divides itself into two distinct parts: "océanographie statique" which deals with the physical and chemical characteristics of the ocean waters and with the topography and deposits of the ocean bottom, and "océanographie dynamique" which deals with the movements of the sea—waves, tides, and currents. After an introductory chapter discussing the province of oceanography and its relation to the various specialized sciences which it employs, five chapters of "océanographie statique" follow, dealing respectively with the extent and depths of the ocean, the bottom of the sea and its deposits, the chemistry of sea water, the physics of sea water, and sea ice. The last three chapters of the volume are devoted to "océanographie dynamique" and deal respectively with waves, tides, and currents.

Thoulet's researches have been largely in the field of "océanographie statique"—a field in which he speaks as a specialist of recognized authority—and no doubt this accounts for the fact that the greater and more interesting portion of "L'Océanographie"—very nearly three fourths of the volume—deals with that part of the subject. "L'Océanographie" is not a manual nor a treatise, its character being very largely determined by the aims of the collection, "Science et Civilisation," in which it appears and whose purpose, the editor informs us, is to make known "au public cultivé les résultats obtenus dans tous les domaines où s'exerce l'activité de l'esprit humain." Because of its interesting presentation of the subject matter of oceanography and despite its meagerness of treatment of tides and tidal phenomena and despite, too, the meagerness of illustrations—eight figures in all—"L'Océanographie" is a welcome volume.

Commandant Rouch, in the introduction to his "Manuel d'océanographie physique," explains that his aim was to produce a practical manual—"such as I myself should like to have had when I left for my first oceanographic work"—and in the reviewer's opinion the author has been eminently successful in his undertaking. The book is divided into two parts. The first part deals with the methods and instruments of observation relating to soundings, temperatures, densities, waves, tides, currents, and sea ice. The second part, constituting the greater portion of the book, discusses the principal results of oceanographic work, a chapter being devoted to each of the following subjects: distribution and general classification of seas, the depths of the ocean, the bottom of the ocean, salinity of sea water, temperature of the ocean waters, color and transparency of the sea, swells and waves, general notions of the tide, causes of the tide, ocean currents, and sea ice. Three appendices follow: the first deals with tow nets, the second lists the oceanographic instruments to be taken along on an oceanographic cruise, and the third gives a number of conversion tables.

By omitting a discussion of the more specialized problems of the various branches of oceanography, the author has succeeded in producing an excellent introductory manual within small compass. Indeed, so well balanced is the presentation of the subject matter that the single chapter in which the treatment is more mathematical and more specialized than is called for in an elementary text—the chapter on the causes of the tide—stands out strikingly. Two quotations may perhaps bring out the author's viewpoint. In speaking of the classification of the seas he says in a footnote "Il faut se garder de donner raison aux détracteurs de la géographie, qui prétendent qu'elle n'est qu'une science de mots et que les géographes sont les derniers 'nominalistes' " (p. 63). In the section dealing with the depths of the sea, after stating that the mean depth of the ocean lies between 3500 and 4000 meters, he appends the following footnote (p. 64): "Krümmel, dans son 'Handbuch der Ozeanographie,' ose écrire 3997 mètres. Qui espère-t-on impressionner avec une pareille précision?"

H. A. MARMER

TROPICAL CYCLONES

E. V. NEWNHAM. **Hurricanes and Tropical Revolving Storms.** With an Introduction on the Birth and Death of Cyclones by Sir Napier Shaw. viii and pp. 213–333; maps, diagrs., bibliogr. *M[eteorol]. O[ffice Publ. No]. 220i, Geophysical Memoirs No. 19,* London, 1922. 12s. 6d. 12 x 10 inches.

Sir Napier Shaw's 14-page "introductory note" deals in a profound manner with the difficult subject of the life history of cyclones. It states the convectional theory of cyclones so as to conform with recent evidence as to barometric conditions in the upper air in cyclones, as well as with Bjerknes' hypothesis of the Polar Front and with Lord Rayleigh's work on revolving fluids in the atmosphere. However, no explanation is offered for the wide variations from year to year in the number of cyclones or for their distribution over the tropics. It is stated that two of the desiderata are a fuller knowledge of local differences in the intensity of convection in the tropics and of localization of precipitation within cyclonic disturbances. Dr. Shaw appears to feel that if these two factors were known the origin and movements of tropical cyclones could perhaps be predicted. One statement is made so radically opposed to that made by Humphreys that it should be quoted. Dr. Shaw says, "nearly all of the tropical cyclones turn out of the easterly drift and recurve into the prevailing westerlies." Since usually more than forty tropical cyclones develop annually in the northern hemisphere, this statement implies an important movement of cyclones from the tropics to mid-latitudes. Humphreys, on the other hand, states ("Physics of the Air," p. 196) that probably only two or three tropical cyclones migrate annually northward out of the tropics.

Mrs. Newnham's 106 pages are a helpful compilation of some of the published data concerning tropical cyclones, especially their frequency in certain regions. It is unfortunate, however, that the compilation has not been more thoroughly done. For instance, very little use was made of the valuable works in German concerning the Pacific and Indian oceans or of the publications of Froc ("Atlas of 620 Typhoons," 1920), and Coronas ("Climate and Weather of the Philippines," 1920) concerning typhoons. No mention is made of tropical cyclones off the west coast of Mexico. Many statements made in the general introduction are contradicted by data, charts, or detailed descriptions given in subsequent pages.

A rather full summary of Fassig's "Hurricanes of the West Indies" (*U. S. Weather Bur. Bull. X*, Washington, D. C., 1913) is given together with mention of storms which occurred in the years 1912–1919. These latter storms are likewise included on the charts of storm tracks by months. Half of the twenty pages are filled with accounts of recent storms, reprinted from the *Monthly Weather Review*. For the years 1876–1919, 159 severe hurricanes are tabulated. Eighty-six per cent occurred during August, September, and October. On the average, four storms occur a year; but in four of the years none occurred, while in five years eight or more have occurred annually.

The next section (11 pages) is on "Storm Squalls and Tornadoes of West Africa," most of the data coming from Henry Hubert. The western Sahara and neighboring regions experience storms rather frequently. They are not, however, of the same type as most of the storms discussed in this memoir, being mostly local and of brief duration. This is remarked in the general introduction but is not made very obvious in the discussion itself. This section might better have been placed in an appendix, together with a discussion of similar

storms of Australia and several other regions. Indeed, information concerning local storms of these severe types is badly in need of compilation.

As might be expected in a British publication, the section on the Indian Ocean is particularly full, forming one-third of the memoir. Fifteen pages are devoted to the cyclones in the Bay of Bengal, ten pages to those of the Arabian Sea, and twelve pages to those of the South Indian Ocean. The discussion of the Bengal cyclones is a summary of Sir John Eliot's comprehensive "Handbook of Cyclonic Storms in the Bay of Bengal" (1900) supplemented by data collected from the Indian *Monthly Weather Review* for the years 1900–1912. The tracks of many of the storms of 1900 to 1912 are shown on charts. As to frequency, on the average ten cyclones occur annually in the Bay of Bengal; of which about two are severe, four are moderately severe, and four are feeble. As to monthly occurrence, July, August, and September each have from 15 per cent to 19 per cent of the storms, while June has 12 per cent, October 14 per cent, and November 10 per cent.

In the Arabian Sea, cyclones are less frequent—about two a year. The data given in the present memoir concerns only 1890–1912, no summary being given of Dallas' memoir discussing the recorded storms occurring before 1889. In monthly occurrence, the cyclones of the Arabian Sea are notable in showing two well-marked maxima, in June and October. Cyclones are very rare or lacking during February and March, when the winter monsoon is blowing steadily, and in August, when the summer monsoon is at its height.

The cyclones of the South Indian Ocean were long studied by Meldrum; and the study was continued until recently by Claxton, lately director of the Royal Alfred Observatory at Mauritius. They are comparatively frequent, nearly ten occurring annually near Mauritius, and others in the general region. Some correspondence between the frequency of the cyclones in the South Indian Ocean and solar spottedness is conceded, although it is stated that the specially severe type of storm appears to be as frequent in years of minimum solar activity as in years of maximum.

The tropical cyclones of the Pacific are considered in 24 pages, half of which are devoted to the typhoons and half to the hurricanes of the South Pacific and Australia. The discussion of typhoons is almost entirely on the basis of Algué's "Cyclones of the Far East" (1904); that of the hurricanes affecting Australia solely from Taylor's "Australian Meteorology"; while most of the data concerning the South Pacific applies only to Fiji and is from a fragmentary report issued by the Colonial Superintendent of Agriculture. Data concerning the tropical cyclones of the Pacific have recently been gathered in the field and from numerous publications by the reviewer. The discussions published in the *Monthly Weather Review* since this memoir was prepared make available many more data.

STEPHEN S. VISHER

THE ENGLISH VILLAGE COMMUNITY

HAROLD PEAKE. **The English Village: The Origin and Decay of Its Community: An Anthropological Interpretation.** 251 pp.; maps, diagrs., ills., bibliogr., index. Benn Bros., Ltd., London, 1922. 15s. 9 x 5¾ inches.

The scope of this volume extends far beyond the limits of geography. Its interest for the geographer lies rather in what it suggests than in what it presents. Its suggestions, however, are manifold. Peake has sought to trace the origin, development, and decay of the community social groups of England and has endeavored to evolve a plan for the reconstruction of the village on lines that will provide a coherent life, satisfying and self-contained, on which future progress might be based.

Criticism of the book is a matter for the anthropologist, historian, and economist. Geography may draw from it certain suggestions for the study of the development of population groups, wherein leads for a method of study are discernible. The village community is traced to its earliest sources, and its prototype is seen by Peake in the Alpine lake dwellings of Switzerland. In developing this origin he takes up a thread which appears again and again in the work in pointing out that the stabilized community system was built upon an aristocracy of steppe folk, who "lorded it" over a serfdom of agriculturists. Hence he deduces the beginnings of the exclusive aristocracy of pre-revolutionary France. From the lake dwellings sprang the nucleated village, while the dispersed village, later giving rise to the forest village in England, appears to have originated in the forested plains of Germany. The appearance of each social form in England is traced as far as knowledge permits, and the modification of the form is followed in detail, being

ascribed mainly to racial influence. The numerous anthropological types to be found in the village itself and in the region are tracked to the distant lands of their origin, and an interpretation of character on the basis of appreciation is attempted in the spirit of the recent series of works on the "Making of the Future," to which Peake was a contributor.

The main geographical implication of the book is the intimate connection between the village and its area, the small territorial subdivision known as the township. The whole history of the development of village and township in England is the history of the reaction of a small social group confined to a small area which was often a geographical unit, or natural district. It is the history of the growth of the group in its district and of the exploitation of the district by the group. It throws a considerable light on the course of population growth under relatively stable conditions of occupation and from this angle has been analyzed at some length in the preceding number of the *Geographical Review* (see pp. 275–278) and will therefore not be further considered here.

M. AUROUSSEAU

A COMPREHENSIVE TREATISE ON THE POPULATION PROBLEM

A. M. CARR-SAUNDERS. **The Population Problem: A Study in Human Evolution.** 516 pp.; bibliogr., index. The Clarendon Press, Oxford, 1922. $7.00. 9 x 6 inches.

This exhaustive and scholarly treatise is an examination of the phenomenon of human propagation and is essentially a biological and sociological work. It deals with man as the special biological case of a species capable of exerting a conscious influence upon its own development and a conscious modification of its own environment. The whole range of human history has been diligently searched for material, and illustrations are culled from every part of the globe.

The author seems to regard the Malthusian statement of the theory of population as inadequate rather than incorrect and has himself arrived at the principle of the "optimum density of population" as an explanation of the nature of human increase. He holds that the principle of the optimum is valid for primitive as well as civilized races and that numbers are adjusted to the optimum for a given region by acceleration of increase in response to economic conditions, if below it, and by more or less conscious check, even among primitive races, if the optimum has been exceeded. The nature and variety of checks upon population growth among savage and primitive peoples are examined in great detail and supported by abundant evidence. The treatment is not statistical but remains empirical throughout and is very convincing. Carr-Saunders' primary effort, unlike that of Pearl and others, is not to state a law of population growth but rather to discover the true nature of the principle of human increase. It cannot be maintained that he has discovered it, but he has undoubtedly indicated a tendency towards conscious adjustment. The quality of human product is considered in detail, a large part of the volume being devoted to a study of the evolution of physical and mental characters and the effects of heredity and tradition. The conclusion is reached that physical improvement of humanity through gradual germinal change is possible but that the effects of germinal change upon mental characters are negligible in the long run, being greatly outweighed by the overwhelming effects of tradition.

There is little in the volume that can be given direct geographical application; but it is a work, nevertheless, which is likely to prove indispensable in demographic geography, as it provides a sound philosophic background and a mass of information of the greatest utility. The liberally summarized table of contents, the classified lists of references, and the index make it an easy and attractive work to consult.

M. AUROUSSEAU